

<b>AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT</b>				1. CONTRACT ID CODE J	PAGE OF PAGES 1   2
2. AMENDMENT/MODIFICATION NO. 0001	3. EFFECTIVE DATE 17-Dec-2002	4. REQUISITION/PURCHASE REQ. NO. W26GLG-2317-3482		5. PROJECT NO.(If applicable) MUHJ 023010	
6. ISSUED BY CONTRACTING OFFICE (CA/CW) US ARMY ENGR DIST NORFOLK ATTN: CENAO-SS-C 803 FRONT STREET NORFOLK VA 23510-1096	CODE DACA65	7. ADMINISTERED BY (If other than item 6) <b>See Item 6</b>		CODE	
8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)				X	9A. AMENDMENT OF SOLICITATION NO. DACA65-03-R-0007
				X	9B. DATED (SEE ITEM 11) 10-Dec-2002
					10A. MOD. OF CONTRACT/ORDER NO.
					10B. DATED (SEE ITEM 13)
CODE	FACILITY CODE				
<b>11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS</b>					
<input checked="" type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer <input type="checkbox"/> is extended, <input checked="" type="checkbox"/> is not extended. Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.					
12. ACCOUNTING AND APPROPRIATION DATA (If required)					
<b>13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.</b>					
A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.					
B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).					
C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:					
D. OTHER (Specify type of modification and authority)					
E. IMPORTANT: Contractor <input type="checkbox"/> is not, <input type="checkbox"/> is required to sign this document and return _____ copies to the issuing office.					
14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.) AMENDMENT NO. 0001 to DACA65-03-R-0007, OPERATIONS SUPPORT CENTER, LANGLEY AIR FORCE BASE, VA.					
Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.					
15A. NAME AND TITLE OF SIGNER (Type or print)			16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)		
			TEL: _____ EMAIL: _____		
15B. CONTRACTOR/OFFEROR  _____ (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA  BY _____ (Signature of Contracting Officer)		16C. DATE SIGNED 17-Dec-2002	

## SECTION SF 30 BLOCK 14 CONTINUATION PAGE

**The following items are applicable to this modification:**CONTINUATION

1. Proposal DUE DATE is January 22, 2003 at 2:00pm. Proposals are to be delivered to the U.S. Army Engineer District, Norfolk, 803 Front Street, ATTN: CENAO-SS-C, Norfolk, VA 23510-1096.
2. SECTION 00010: DELETE Bidding Schedule in its entirety and REPLACE with the attached.
3. SECTION 00110: ADD the attached Section 00110 in its entirety.
4. SECTION 00120: ADD the attached Section 00120 in its entirety.
5. SECTION 00800: FAR 52.211-12, Liquidated Damages, Construction, DELETE "to be provided with a subsequent amendment" and REPLACE with \$4,057.00".
6. Technical plans and specifications are hereby incorporated in accordance with the attached.

Section 00010 - Solicitation Contract Form

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0001	SCHEDULE I - BASE FFP Construct Operations Support Center Building, complete, including all work incidental thereto as shown on the drawings and specified exclusive of items 0002 thru 0007. PURCHASE REQUEST NUMBER: W26GLG-2317-3482	1	Lump Sum		

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NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0002	FFP Sitework associated with Operations Support Center Building, complete including all work incidental thereto as shown on the drawings and specified exclusive of items 0001 and 0003 thru 0007.	1	Lump Sum		

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NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0003		19,992	Square Yard		

FFP

Parking lot pavement associated with the Operations Support Center, complete including parking lot rough grading, curbs & gutters, barriers, landscaping, lighting, and all work incidental thereto as shown on the drawings and specified exclusive of items 0001, 0002, 0004 and 0007.

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NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0004		1	Lump Sum		

FFP

Building 15 Loop Road, complete, including all work incidental thereto as shown on the drawings and specified exclusive of bid items 0001 thru 0003 and 0005 thru 0007.

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NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0005		1	Lump Sum	30,000	30,000

FFP

As-Built drawings for Operations Support Center building, complete, including all work incidental thereto as shown on the drawings and specified exclusive of bid items 0001 thru 0004, 0006 and 0007.

30,000

NET AMT

TOTAL SCHEDULE I - BASE

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0006		1	Lump Sum		

SCHEDULE II - OPTIONAL ITEMS

FFP

Construct finished attic in the Operations Support Center building, complete, including all work incidental thereto as shown on the drawings and as specified exclusive of bid items 0001 thru 0005 and 0007.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0007		1	Lump Sum		

FFP

Dorm lot parking addition, complete, including all work incidental thereto as shown on the drawings and specified exclusive of bid items 0001 thru 0006.

NET AMT

TOTAL SCHEDULE II – OPTIONAL ITEMS

TOTAL SCHEDULE I + II {BASE + OPTION ITEMS}

**SECTION 00110**  
**PROPOSAL SUBMISSION REQUIREMENTS AND INSTRUCTIONS**

**SECTION 00110  
PROPOSAL SUBMISSION REQUIREMENTS AND INSTRUCTIONS**

**1.00 PROPOSAL SUBMISSION INSTRUCTIONS.**

a. General. Inasmuch as this proposal will describe the capability of the offeror to perform any resultant contract, it should be specific and complete in every detail. The proposal should be prepared simply and economically, providing straightforward, concise delineation of capabilities to perform satisfactorily the contract being sought. The proposal should therefore be practical, legible, clear and coherent.

b. Format of Proposals. In order that the evaluation may be accomplished strictly on the merit of the material submitted, no dollar amounts for the proposed work are to be included in the proposal. In order that the evaluation may be accomplished efficiently, the evaluation criteria listed below in this section are to be addressed in order. **WARNING:** The proposals are evaluated in direct correspondence to the evaluation criteria, which are included in Section 00120. It is in the best interest of the offerors to format the proposal in the order of the evaluation criteria. If the offeror fails to provide information relating to the criteria or locates the information in another part of the proposal without providing any cross references, the offeror runs the risk of having their proposal receive a lower evaluation by the Government evaluators who were not able to locate the appropriate information.

c. In addition to the proposal requirements outlined in this Section, each proposal shall contain:

- (1) Title Page, including the title of the solicitation, solicitation number, and date of the submittal.
- (2) Table of Contents, including a list of tables or exhibits.

d. Exceptions to the contractual terms and conditions of the solicitation (e.g., standard company terms and conditions) must not be included in the proposal.

**2.00 PROPOSAL REQUIREMENTS:**

a. Who May Submit?

- (1) Proposals may be submitted by construction contractors that have associated specifically for this project.

b. General Requirements.

- (1) In order to effectively and equitably evaluate all proposals, the Contracting Officer must receive information sufficiently detailed to clearly indicate the personnel references provided.

c. Size of Printed Matter Submissions.

- (1) Written materials: Size A4 [or 8-1/2" x 11"] format. Proposal shall be limited to a maximum of 60 typewritten pages (excluding Subcontracting Plan). The government will review only 60 pages. Table of Contents and Tab Sheets between sections is not included in the 60 pages. The technical evaluation board will not evaluate any documentation beyond the 60 pages.

d. Where to Submit.

Offerors shall submit their proposal packages to Norfolk District at the address shown in Block 8 of Standard Form 1442.

e. Submission Deadline.

Proposals shall be received by the Norfolk District no later than the time and date specified in Block 13 of Standard Form 1442.

## Operations Support Center (OSC), Langley Air Force Base, Virginia

### f. Proposal Requirements and Submission Format.

#### PHASE I

The proposals sought by this solicitation shall contain the four categories of submittal information outlined below. Factors 1 thru 3 shall be submitted together in a three ring binder (original and four copies). Factor 4 shall be submitted in a separate three ring binder (original and one copy)

Each binder shall include a complete detailed table of contents. Any materials submitted but not required by this solicitation such as company brochures, shall be relegated to appendices.

#### (1) Factor 1: Past performance

(a) Past Performance: *Provide three completed Past Performance Evaluation Questionnaires using the attached "Past Performance Evaluation Questionnaire" form. Completed forms must be received by the submission deadline specified in Block 13 of Standard Form 1442.*

*Submit a list of all new construction projects over \$15 million performed by the contractor. Use the attached "Corporate Experience Form".*

(b) Experience Modifier Ratio: *Provide your firm's Experience Modifier Ratio for the last five calendar years.*

#### (2) Factor 2: Contract Duration:

*Submit proposed construction duration for completion of the new Operations Support Center (excluding time for occupant move-in and excluding the phases for demolition of existing Buildings 18, 20 and 23 and parking lot construction), which is equal to or less than the maximum duration of 515 calendar days.*

#### (3) Factor 3: Small Business Subcontracting Effort:

(a) Past Performance: Support for small business and small disadvantaged business and women-owned business program.

(b) Subcontracting Plan Effort

#### PHASE 2

#### Factor 1: PRICE.

Pro Forma requirements:

This information should be submitted in an envelope labeled "Pro Forma Requirements." This category consists of representations and certifications, subcontracting plan, completed Standard Form 1442. Provide original and one (1) copy.

g. Nonresponsive proposals. Failure to submit all the data indicated is cause for determining a proposal nonresponsive and, therefore, not considered for evaluation or award.

SECTION 00120  
PROPOSAL EVALUATION AND CONTRACT AWARD

**1. PROPOSAL EVALUATION.**

The major factors in Phase One of consideration in the evaluation of proposals received in response to this solicitation are as follows:

(1) Factor 1: Past Performance

(2) Factor 2: Contract Duration.

(3) Factor 3: Support for small business and small disadvantaged business and women-owned business program.

The major factors in Phase Two of consideration in the evaluation of proposals received in response to this solicitation are as follows:

Factor 1: Price

**2. EVALUATION PROCESS**

The proposal and evaluation process for this project will take place in two Phases. Each step will present unique requirements to the potential proposers. The proposers responses to these requirements will be evaluated with respect to the evaluation criteria set forth below.

**Phase 1** will concern itself with Past Performance-Construction, Contract Duration, and Technical Approach and Support for Small Business and Small Disadvantaged Business and Women-Owned Business Program. All proposals received in response to Phase 1 will be evaluated and scored. At most, five (5) proposals will move forward into Phase 2, which will represent the proposer's price.

**Phase 2** Only the five (at most) proposers who reach Phase 2 will be provided the opportunity to submit a price.

The final evaluation score for each proposal will represent the ratings received in Phase 1 and cost in Phase 2.

**3. BASIS OF AWARD**

(1). The Government will award a firm fixed-price contract to that responsible Offeror whose proposal, conforming to the solicitation, is fair and reasonable, and has been determined to be most advantageous to the Government, with quality (comprised of technical approach and performance capability factors), price and other factors considered. The rated/scored evaluation criteria and price are considered approximately equal. As evaluation scores and relative advantages and disadvantages become less distinct, differences in price between proposals are of increased importance in determining the most advantageous proposal. Conversely, as differences in price become less distinct, differences in scoring and relative advantages and disadvantages between proposals are of increased importance to the determination.

(2). The Government reserves the right to accept other than the lowest priced offer. The right is also reserved to reject any and all offers. The basis of award will be a conforming offer; the price or cost of which may or may not be the lowest. If other than the lowest priced offer is

accepted, that offer must be sufficiently more advantageous than the lowest priced offer to justify the payment of additional amounts.

(3). Offerors are reminded to include their best technical and price terms in their initial offer and not to automatically assume that they will have an opportunity to participate in discussions or be asked to submit a revised offer. The Government may make award of a conforming proposal without discussions, if deemed to be within the best interests of the Government.

#### 4. Phase 1 EVALUATION CRITERIA:

##### 1. OFFEROR'S PAST PERFORMANCE.

###### Sub-factor I.

Submit a list of all new construction projects over \$15 million performed by the contractor. Past performance on military construction projects is preferred. Include Corporate Experience Forms for the electrical and communications subcontractors that will be used on this project. Each of these subcontractors should be included on a minimum of three forms. These subcontractor forms may be any combination of projects already submitted for the prime contractor (in which case a separate form will not be required) or separate projects. Note carefully that these subcontractors are to be the subcontractors that will be used on this project, not merely potential subcontractors. If the communications subcontract is to be a second-tier subcontract under the electrical subcontract, Corporate Experience Forms for the firm that will be installing the communications system will still be required. Past performance on secure facilities and on subcontract amounts in excess of \$2 million is preferred for each of these subcontractors. Include only projects completed within the last five years or projects currently under construction and over 50% complete. Do not include indefinite delivery or task order contracts, unless individual task orders meet the criteria of new construction over \$15 million (or \$2 million in the case of subcontractors). Include awards, customer letters of commendation, etc, with points of contact and telephone numbers. Points of contact should include the office that administered the project (e.g. ROICC, Resident Office, etc.). **Use the attached Corporate Experience Form.** The government will use references from offeror's submission under the "Corporate Experience", CCASS system, and other sources. **The Contractor shall be responsible for submitting three completed "Past Performance Evaluation Questionnaires" using the attached "Past Performance Evaluation Questionnaire" forms.** Should the offerors believe that the number of submissions under "Corporate Experience" is inadequate, they may submit a maximum of ten additional forms. Submit past performance narratives for the Team to include three (3) to five (5) recent projects that demonstrate construction and incidental related work including demolition, renovation, additions and new construction of similar facilities.

This evaluation is separate and distinct from the Contracting Officer's responsibility determination. The assessment of the offeror's past performance will be used as a means of evaluating the relative capability of the Offeror to successfully meet the requirements of the RFP.

###### Sub-factor II.

Submit your firm's Experience Modifier Ratio for the last five (5) calendar years along with the computed average of those five. If there are extenuating circumstances concerning your rating, provide background information and references for validation. If ratings are not provided without explanation, offerors will receive an unacceptable rating.

## Operations Support Center, Langley Air Force Base, Virginia

### 2. CONTRACT DURATION.

Submit a proposed construction duration for completion of the new Operations Support Center (excluding time for occupant move-in and excluding the phases for demolition of existing Bldgs 18, 20 and 23 and parking lot construction) which is equal to or less than the maximum duration (515 calendar days) specified in Section 01005. Durations shorter than the maximum specified in Section 01005 are preferred. The duration proposed by the successful offeror will become the contractually required duration. (Note that this factor applies only to construction of the new facility. Note also that maximum duration for parking lot phases shall be as specified in Section 01005 .)

### 3. SUPPORT FOR SMALL BUSINESS AND SMALL DISADVANTAGED BUSINESS AND WOMEN-OWNED BUSINESS

#### Subfactor 3A:

Small Business Past Performance: If large business, contractors are required to submit a recent Standard Form 294, Subcontracting Report for Individual Contracts and SF 295, Summary Report to evaluate past performance in support of Small Business and Small Disadvantaged Business and Women-Owned Small Businesses. For Small Businesses, contractors are not required to submit a subcontracting plan or a SF 294 or SF 295, but must self certify as a Small Business.

#### Subfactor 3B:

Subcontracting Plan Effort: The following is submitted to satisfy the applicable requirements for the subcontracting plan effort factor. If a large business, contractors are required to submit a subcontracting plan, which conforms to the requirements of FAR 5.219-9 and DFARS Clause 252.219-7003. The plan will be evaluated for support of Small Business, Small Disadvantaged Business, and Women- Owned Small Business and considering the following:

1. The extent to which such firms is specifically identified.
2. The extent of commitment to use such firms.
3. The complexity and variety of the work small firms are to perform.
4. The realism of the proposal.
5. The extent of participation of such firms in terms of the value of the total acquisition.

Note: Secretary of the army goals for subcontracting are:

- 62% for Small Business
- 9% for Small Disadvantaged Business
- 5% for Women-Owned Business
- 2% for Hubzone Business
- 3% for Small Business Veteran Owned

Small business offers shall certify their status as Small business and will be rated **EXCEPTIONAL** for this factor.

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### 5. Phase 2 **EVALUATION CRITERIA**

#### a. PRICE

6. **RATING SCHEME**

- A. **Adjective Ratings.** The following adjective ratings will be used in evaluation of both the major technical factors and the technical sub-factors. Use uppercase letter ratings for major technical factors as well as the overall rating. Use lowercase letter ratings for technical sub-factors.

**Superior (S):** Proposal meets the minimum SOLICITATION requirements for this item and has salient features that offer significant advantages to the Government.

**Above Average (AA):** Proposal meets the minimum SOLICITATION requirements for this item and has salient features that offer advantages to the Government.

**Acceptable (A):** Proposal meets the minimum SOLICITATION requirements for this item.

**Unacceptable but capable of becoming acceptable (UCA):** Proposal meets most of the minimum requirements for this item, but offers weak area or mimics SOLICITATION language rather than offering understanding of the requirements.

**Unacceptable (U):** Proposal meets some but not all the minimum requirements for this item or does not address all required criteria.

- B. **Overall Rating.** Overall proposal ratings shall be assigned with strong consideration given to the most heavily weighted factors.

CORPORATE EXPERIENCE FORM

DACA65-03-R-0007

Offeror: \_\_\_\_\_

Project Title: \_\_\_\_\_

Contract Number: \_\_\_\_\_

Location: \_\_\_\_\_

Contract Completion Duration: \_\_\_\_\_

Original Value: \_\_\_\_\_ Final Value: \_\_\_\_\_

Type of Contract: \_\_\_\_\_ Fixed Price \_\_\_\_\_ Cost Reimbursable

ProjectDescription: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

List Name of your company's subcontractors on this project, the trade worked, the dollar value of project(s) the company worked on previously and the \$ value of subcontract contemplated.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Customer Contact:

\_\_\_\_\_

Name

\_\_\_\_\_

Organization

\_\_\_\_\_

Address

\_\_\_\_\_

Telephone Number

Circle one:

P = Prime Contractor

S = Subcontractor

PERSONNEL REFERENCES

DACA65-03-R-0007

Offerors shall use this form to submit the required reference information on all key personnel. The government intends to contact the actual references.

1. Name of employee:
2. Name, address and phone number of employer, and point of contact:
3. Position(s) held:
4. Years employed:
5. Types of projects, and dollar value, worked on while employed with subject employer:

**SAMPLE TRANSMITTAL LETTER  
AND  
PAST PERFORMANCE EVALUATION QUESTIONNAIRE**

Date: \_\_\_\_\_

To: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

We have listed your firm as a reference for work we have performed for you as listed below. Our firm has submitted a proposal under a project advertised by the U.S. Army Corps of Engineers, Norfolk District. In accordance with Federal Acquisition Regulations (FAR), an evaluation of our firm's past performance will be completed by the Corps of Engineers. Your candid response to the attached questionnaire will assist the evaluation team in this process.

We understand that you have a busy schedule and your participation in this evaluation is greatly appreciated. Please complete the enclosed questionnaire as thoroughly as possible. Space is provided for comments. Understand that while the responses to this questionnaire may be released to the Offeror, FAR 15.306 (e)(4) prohibits the release of the names of the persons providing the responses. Complete confidentiality will be maintained. Furthermore, a questionnaire has also been sent to \_\_\_\_\_ of your organization. Only one response from each office is required. If at all possible, we suggest that you individually answer this questionnaire and then coordinate your responses with that of \_\_\_\_\_, to forge a consensus on one overall response from your organization.

Please send your completed questionnaire to the following address:

U.S. Army Engineer District, Norfolk  
ATTN: Debbie Gray  
803 Front Street  
Norfolk, VA 23510

The questionnaires can also be faxed to Ms. Gray at (757) 441-7551. If you have questions regarding the attached questionnaire, or require assistance, please contact Ms. Gray at phone (757) 441-7551. Thank you for your assistance.

**PAST PERFORMANCE EVALUATION QUESTIONNAIRE**

Upon completion of this form, please send directly to the U.S. Army Corps of Engineers in the enclosed addressed envelope or fax to (757) 441-7183, ATTN: Ms. Debbie Gray. Do not return this form to our offices. Thank you.

1. Contractor/Name & Address (City and State):

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2. Type of Contract: Fixed Price \_\_\_\_\_ Cost Reimbursement \_\_\_\_\_  
Other (Specify) \_\_\_\_\_

3. Title of Project/Contract Number:

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4. Description of Work: (Attach additional pages as necessary)

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5. Complexity of Work: High \_\_\_\_\_ Mid \_\_\_\_\_ Routine \_\_\_\_\_

6. Construction Cost: \_\_\_\_\_

7. Location of Work: \_\_\_\_\_  
\_\_\_\_\_

8. Date of Award: \_\_\_\_\_

9. Status: Active \_\_\_\_\_ (provide percent complete)  
Complete \_\_\_\_\_ (provide completion date)

10. Name, address and telephone number of Owner or Contracting Officer's Technical Representative:

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Operations Support Center, Langley Air Force Base, Virginia

## SECTION 01005

PROJECT WORK REQUIREMENTS AND RESTRICTIONS  
07/00

## PART 1 GENERAL

## 1.1 DEFINITIONS

- a. Facility: The facility is Langley Air Force Base, Virginia.
- b. CO: Contracting Officer or his authorized representative.

## 1.2 COOPERATION WITH USING AGENCY AND OTHER CONTRACTORS

During the period of this contract, other contracts may be in force for the construction of other features of work on or adjacent to the site of work being accomplished under this contract. It shall be the responsibility of the Contractor on this contract to be fully informed of the extent of the limits of work to be performed by other Contractors. Should there be any conflict between these limits, it shall be brought to the attention of the Contracting Officer and the CO's decision shall be final. Also, prior to completion of work under this contract, members of the Using Agency may be performing work or occupying facilities on or adjacent to the area. The Contractor shall arrange his plant and shall schedule and perform this work so as to effectively cooperate with all other Contractors and Government agencies.

## 1.3 PERSONNEL RESTRICTIONS

Personnel are limited to the immediate site areas and shall not enter buildings or facilities not involved in the work. All employees of the Contractor will be subject to all rules and regulations of the Facility which pertain to personnel. The Contractor shall erect fences and signs as specified and be responsible for the restrictions of all personnel. The Contractor's plans for restricting personnel access to the project site shall be submitted for approval as a part of the Safety Plan (Accident Prevention Plan).

## 1.4 TRANSPORTATION FACILITIES

The Facility is served by an all weather surfaced road network. Road(s) within the Facility proposed to be used by the Contractor shall be subject to prior approval of the Facility authorities and such roads, if used, shall be maintained throughout construction and shall be restored to as good condition as existed prior to their use. The Contractor shall also construct, subject to approval, such temporary haul roads and bridges as may be necessary for conducting his work. Any such temporary construction shall be removed and the affected area restored to its original condition. All costs for the use of existing transportation facilities, for the construction of temporary facilities, and for maintenance, repair, removal and restoration shall be borne by the Contractor.

## 1.4.1 Use of Roads

The Contractor shall keep all roads clear of all obstructions and free of mud and other foreign materials resulting from operations. The Contractor's vehicles shall at no time follow a vehicle closer than 50 feet, and all vehicles shall pull off the road and come to a complete stop

when meeting emergency vehicles and vehicles with flashing lights. Facility speed limits and traffic controls will be observed. Contractor haul route shall be provided by the Contracting Officer at the Preconstruction Conference. Base access will be through the Lasalle Gate or through the West Gate at the Governments disposition.

#### 1.4.2 Road Restrictions

The movement of all vehicles within the Facility shall be confined to the roads designated and shall comply with traffic regulations within the Facility. Other roads may be used only with the approval of the CO.

##### 1.4.2.1 Cleated Vehicles

Cleated vehicles shall not be moved over surfaced roads except at the immediate site of the area where they are to be used.

#### 1.5 COORDINATION IN WORK AREAS

##### 1.5.1 Unoccupied Work Area

The area where the Contractor is scheduled to perform the work will not be occupied during the work, however, the Contractors work activities may affect other area(s) that are occupied. All work shall be in accordance with the Contractor's work plan.

##### 1.5.2 Maintenance of Utilities

Any active utilities, including but not limited to electricity, gas, water, sewer, heating, air conditioning, or any like service, that will require interruption or replacement in any occupied area affected as a result of the Contractors scheduled work activities, shall be temporarily provided by the Contractor at his own expense until the affected service is fully and permanently restored. All temporary method(s) of service replacement the Contractor proposes for use on this contract shall be approved by the Contracting Officer prior to commencing the work.

##### 1.5.3 Hours of Work

The normal work hours for construction shall be from 7:00 a.m. to 5:00 p.m., Monday through Friday of each week. Any request to change these hours shall be made in writing to the Contracting Officer at least two calendar days prior to the desired day on which the change is to go into effect. The changed hours shall not go into effect until written permission has been received from the Contracting Officer.

##### 1.5.4 Digging Permits

Contractor is responsible for obtaining all digging permits, including associated locating and marking services, in accordance with installation and local requirements, at no additional cost to the Government.

#### 1.6 PHASING

This project shall be accomplished in two phases to allow for continued use of Buildings 18, 20, and 21 until the proposed OSC Building is constructed and occupied.

Phase 1 includes installation of Erosion and Sediment Control measures,

initial site preparation, the demolition of an underground bunker, removal of a parking area south of Building 18, installation of roadway barriers and the removal of a section of Rickenbacker Road, clearing and grubbing of trees within the construction area and the surrounding Force Protection Zone and the removal of several minor structures within the planned construction limits all as shown on the plans. During the demolition process, the Contractor shall take care to protect the existing 10-inch water main on the south side of Rickenbacker Road until the water main is re-routed as shown on the plans. The existing high voltage overhead electrical service on the north side of Rickenbacker Road and the underground communications lines along Elm Street and Rickenbacker Road shall be protected and maintained until the proposed OSC Building is occupied and operation. The OSC Building shall be constructed and accepted by the Government during Phase 1. Removal and replacement of Building 15 loop road and construction of drainage system shall also be completed during Phase 1. The Contractor shall allow for a 60 day period from the Completion of Phase 1 to the start of Phase 2 for the Government to move into the OSC Building and vacate the buildings to be demolished in Phase 2.

Phase 1A includes the portion of west parking lot associated with the OSC Building. Construction of this parking area shall not commence until six months after notice to proceed is issued but shall be completed no later than the remainder of Phase 1.

Phase 2 includes the demolition of Buildings 18, 20, and 21 and the surrounding parking areas and the remaining sections of Rickenbacker Road. Utilities serving the buildings shall be disconnected and capped or removed as shown on the plans and in accordance with the specifications. The overhead high voltage lines and poles along the north side of Rickenbacker Road shall be removed. New work includes placing additional fill; widening a section of Elm Avenue; construction of re-aligned Rickenbacker Road and several paved parking areas together with the associated storm drainage; installation of landscaping and an irrigation system, all as shown on the plans.

#### 1.6.1 Electrical and Communications Phasing Sequence

The following sequence is provided as a guide to assist the Contractor in phasing the construction work in relation to the electrical and communications systems. The Contractor shall submit a detailed phasing sequence plan for approval by the Contracting Officer, including but not limited to specific items of phasing, dates and/or timeline for each, complete details on items requiring temporary services and/or rerouting existing services.

a. The following shall be accomplished under Phase 1:

- (1) All work at the existing main electrical station on the corner of Elm Street and Sweeney.
- (2) Provide new 22KV ductbank and cabling system down Elm Street, new 4 way MV pad mounted switch adjacent courtyard, new electrical secondary unit substation, new packaged generator, new outdoor walk-in main electrical switchgear, feeders and manholes within the Phase 1 lines indicated on the civil plans, and all related work.
- (3) Provide part of the exterior lighting and related underground circuitry up to the Phase 1 limit line.

- (4) Upgrade the existing overhead to three phase, new underground 4.16 KV ductbank and cabling system reroute; demolish part of the existing overhead 4.16 KV system back to the Phase 1 line limits.
- (5) Provide the exterior communications ductbank system up to the Phase 1 limit lines.
- (6) Provide the exterior communications ductbank to Building 19, complete.
- (7) All interior and perimeter work for the new operations support center building.
- (8) Buildings 18 and 21 shall remain completely operational until required to be demolished under Phase 2.

b. The following shall be accomplished under Phase 2:

- (1) Demolish the remaining portion of the existing overhead 4.16 KV circuit as indicated.
- (2) Provide remainder of 22 KV system work indicated, including new 4 way MV switch, new feeders to Building 15 transformer, new portions of 22 KV cabling in existing ducts, and associated demolition, etc.
- (3) Remove services from and provide demolition of existing Buildings 18 and 21, complete.
- (4) Provide the remaining of the exterior lighting and related underground circuitry.
- (5) Encase existing underground communications ductbank.
- (6) Provide the remaining underground communications ductbank system indicated.
- (7) All remaining work.

## 1.7 INTERRUPTIONS OF UTILITIES

### 1.7.1 Approval

Utility services shall not be interrupted by the Contractor to relocate, make connections, or interrupt for any purpose, without written approval of the Contracting Officer.

### 1.7.2 Request

Request for permission to shut down services shall be submitted in writing to the Contracting Officer not less than 10 calendar days prior to date of proposed interruption. The request shall give the following information:

- a. Nature of Utility (Gas, L.P. or H.P., Water, Elec.)
- b. Size of line and location of shutoff.
- c. Buildings and services affected.

- d. Hours and date of shutoff.
- e. Estimated length of time service will be interrupted.

#### 1.7.3 Service Interruptions

Services shall not be shut off until receipt of approval of the proposed hours and date from the Contracting Officer.

#### 1.7.4 Timely Disconnections

Shutoffs which will cause interruption of Government work operations as determined by the Contracting Officer shall be accomplished during regular non-work hours or non-work days of the Using Agency without any additional cost to the Government.

#### 1.7.5 Utilities Operation

Operation of valves on water mains will be by Government personnel. Where shutoff of water lines interrupts service to fire hydrants or fire sprinkler systems, the Post Fire Department shall be notified by the Contractor in writing 72 hours prior to the proposed interruption. The Contractor shall arrange his operations and have sufficient material and personnel available to complete the work without undue delay and shall restore service without delay in event of emergency.

#### 1.7.6 Gas

Flow in gas mains which have been shut off shall not be restored until the Government inspector has determined that all items serviced by the gas line have been shut off.

#### 1.8 PHYSICAL DATA

The physical conditions indicated on the drawings and in the specifications are the result of borings. See Section 01055 SOIL BORING DATA for boring logs and data.

#### 1.9 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER

This provision specifies the procedure for the determination of time extensions for unusually severe weather in accordance with the Contract Clause entitled "Default: (Fixed Price Construction)". In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

- a. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.
- b. The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor.

##### 1.9.1 Schedule

The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar

data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY  
WORK DAYS BASED ON (5) DAY WORK WEEK

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Langley AFB	9	9	9	6	7	6	7	7	5	6	7	9

### 1.9.2 Records

Upon acknowledgement of the Notice to Proceed and continuing throughout the contract, the contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day.

### 1.9.3 Impacted Days

The number of actual adverse weather days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day in each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in the schedule of monthly anticipated adverse weather delays, above, the contracting officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the Contract Clauses entitled "Default (Fixed Price Construction)".

## 1.10 SITE CONTAMINATION

This site is designated a Category I site and is defined as a site that is located in a traditional non-hazardous location, such as in an administrative, recreation, or housing area and that the Government has no reason to suspect contamination.

### 1.10.1 Compliance Requirements

The Contractor shall comply with applicable Federal, state and local laws, codes, ordinances and regulations (including the obtaining of licenses and permits) in connection with any hazardous material, substance or waste.

### 1.10.2 Requirements

The requirements of this clause and any act or failure to act by the Government shall not relieve the Contractor of any responsibility or liability for the safety of Government, Contractor or subcontractor personnel or property.

### 1.10.3 Contamination

In the event that contamination beyond that shown or specified is encountered, the Contracting Officer shall be advised immediately. The contamination shall be removed as directed and replaced with satisfactory

material. Payment therefor will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES.

#### 1.11 WORK IN QUARANTINED AREA

The work called for by this contract involves activities in counties quarantined by the Department of Agriculture to prevent the spread of certain plant pests which may be present in the soil. The Contractor agrees that all construction equipment and tools to be moved from such counties shall be thoroughly cleaned of all soil residues at the construction site with water under pressure and that hand tools shall be thoroughly cleaned by brushing or other means to remove all soil. In addition, if this contract involves the identification, shipping, storage, testing, or disposal of soils from such a quarantined area, the Contractor agrees to comply with the provisions of ER 1110-1-5 and attachments, a copy of which will be made available by the Contracting Officer upon request. The Contractor agrees to assure compliance with this obligation by all subcontractors.

#### 1.12 HISTORICAL AND ARCHAEOLOGICAL FINDS

Federal legislation provides for the protection, preservation, and collection of scientific, prehistorical, historical, and archaeological data, including relics and specimens which might otherwise be lost due to alteration of the terrain or building features as a result of any Federal construction project. Should the Contractor, or any of the Contractor's employees, or parties operating or associated with the Contractor, in the performance of this contract discover evidence of possible scientific, prehistorical, historical, or archaeological data, the Contractor shall immediately cease work at that location and notify the Contracting Officer, giving the location and nature of the findings. The Contractor shall forward written confirmation to the Contracting Officer as directed. The Contractor shall exercise care so as not to disturb or damage artifacts or fossils uncovered during excavation operations, and shall provide such cooperation and assistance as may be necessary to preserve the findings for removal or other disposition. Any person who, without permission, injures, destroys, excavates, appropriates, or removes any historical or prehistorical artifact, object of antiquity, or archaeological resource on the public lands of the United States is subject to arrest and penalty of law. Where appropriate by reason of discovery, the Contracting Officer may order delays in the time of performance or changes in the work, or both. If such delays or changes are ordered, an equitable adjustment will be made in the contract in accordance with the applicable clauses of the contract.

#### 1.13 EQUIPMENT-IN-PLACE LIST:

The Contractor shall maintain a list of equipment installed under the terms of the contract. In the event that the contract includes more than one building or facility, a list must be maintained for each and delivered to the Contracting Officer upon acceptance of each building or facility. Forms to be used for this purpose shall be obtained from the Area Engineer's Office. The list shall include the following:

- a. Contract number
- b. Description of item
- c. Model number
- d. Serial number
- e. Capacity
- f. Name of manufacturer

- g. Address of manufacturer
- h. Condition of item
- i. Replacement cost
- j. Name of person who checked item

#### 1.14 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE

##### 1.14.1 Allowable Costs

Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a Contractor or subcontractor at any tier shall be based on actual cost data when the Government can determine both ownership and operating costs for each piece of equipment or equipment groups of similar serial and series from the Contractor's accounting records. When both ownership and operating costs cannot be determined from the Contractor's accounting records, equipment costs shall be based upon the applicable provisions of EP 1110-1-8, "Construction Equipment Ownership and Operating Expense Schedule," Region II. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the Contracting Officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retrospective pricing, the schedule in effect at the time the work was performed shall apply.

##### 1.14.2 Rental Costs

Equipment rental costs are allowable, subject to the applicable provisions of the Federal Acquisition Regulations, and shall be substantiated by certified copies of paid invoices. Rates for equipment rented from an organization under common control, lease-purchase or sale-leaseback arrangements will be determined using the schedule except that rental costs leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees are allowable. Costs for major repairs and overhaul are unallowable.

##### 1.14.3 Equipment Costs

When actual equipment costs are proposed and the total amount of the pricing action is over \$25,000, cost or pricing data shall be submitted on the Standard Form 1411, "Contract Pricing Proposal Cover Sheet". By submitting cost or pricing data, the Contractor grants to the Contracting Officer or an authorizing representative the right to examine those books, records, documents and other supporting data that will permit evaluation of the proposed equipment costs. After price agreement the Contractor shall certify that the equipment costs or pricing data submitted are accurate, complete and current.

##### 1.14.4 Marine Equipment

In determining the ownership expense for marine equipment as described in the Schedule, the average use per year shall be 8 months.

#### 1.15 SUBCONTRACTS AND WORK COORDINATION

Contract Clauses "SUBCONTRACTS", "PERMITS AND RESPONSIBILITIES", and "MATERIAL AND WORKMANSHIP" are supplemented as follows:

- a. Divisions or sections of specifications are not intended to control the Contractor in dividing the work among subcontractors, or to limit work performed by any trade.
- b. Contractor shall be responsible for coordination of the work of the trades, subcontractors, and materials.
- c. The Government or its representative will not undertake to settle any difference between the Contractor and Contractor's subcontractors, or between subcontractors.
- d. The Government reserves the right to refuse to permit employment on the work or require dismissal from the work of any subcontractor who, by reason of previous unsatisfactory work on Corps of Engineers projects, or for any other reason is considered by the Contracting Officer to be incompetent or otherwise objectionable.

1.16 CONSTRUCTION MANPOWER AND EQUIPMENT REPORT

The Contractor shall submit daily reporting in accordance with the Resident Management System (RMS). The report shall include manpower and equipment for the general and subcontractors. See Section 01312, "Resident Management System (RMS)."

1.17 PROFIT

1.17.1 Weighted Guidelines

Weighted guidelines method of determining profit shall be used on any equitable adjustment change order or modification issued under this contract. The profit factors shall be as follows:

Factor	Rate	Weight	Value
Degree of Risk	20		
Relative difficulty of work	15		
Size of Job	15		
Period of performance	15		
Contractor's investment	05		
Assistance by Government	05		
Subcontracting	<u>25</u>		
	100		

1.17.2 Value

Based on the circumstances of each procurement action, each of the above factors shall be weighted from .03 to .12 as indicated below. The value shall be obtained by multiplying the rate by the weight. The value column when totalled indicates the fair and reasonable profit percentage under the circumstances of the particular procurement.

1.17.2.1 Degree of Risk

Where the work involves no risk or the degree of risk is very small, the weighting should be .03; as the degree of risk increases, the weighting should be increased up to a maximum of .12. Lump sum items will have,

generally, a higher weighted value than the unit price items for which quantities are provided. Other things to consider: the portion of the work to be done by subcontractors, nature of work, where work is to be performed, reasonableness of negotiated costs, amount of labor included in costs, and whether the negotiation is before or after performance of work.

#### 1.17.2.2 Relative Difficulty of Work

If the work is most difficult and complex, the weighting should be .12 and should be proportionately reduced to .03 on the simplest of jobs. This factor is tied in to some extent with the degree of risk. Some things to consider: the nature of the work, by whom it is to be done, where, and what is the time schedule.

#### 1.17.2.3 Size of Job

All work not in excess of \$100,000 shall be weighted at .12. Work estimated between \$100,000 and \$5,000,000 shall be proportionately weighted from .12 to .05.

#### 1.17.2.4 Periods of Performance

Jobs in excess of 24 months are to be weighted at .12. Jobs of lesser duration are to be proportionately weighted to a minimum of .03 for jobs not to exceed 30 days. No weight where additional time not required.

#### 1.17.2.5 Contractor's Investment

To be weighted from .03 to .12 on the basis of below average, average, and above average. Things to consider: amount of subcontracting, mobilization payment item, Government furnished property, equipment and facilities, and expediting assistance.

#### 1.17.2.6 Assistance by Government

To be weighted from .12 to .03 on the basis of average to above average. Things to consider: use of Government owned property, equipment and facilities, and expediting assistance.

#### 1.17.2.7 Subcontracting

To be weighted inversely proportional to the amount of subcontracting. Where 80 percent or more of the work is to be subcontracted, the weighting is to be .03 and such weighting proportionately increased to .12 where all the work is performed by the Contractor's own forces.

PART 2 PRODUCTS (THIS PART NOT USED)

PART 3 EXECUTION (THIS PART NOT USED)

-- End of Section --

## SECTION 01055

SOIL BORING DATA  
03/98

## PART 1 GENERAL

The boring logs representing the subsurface investigation at the site are indicated in the drawing set.

## 1.1 BORING LOCATIONS

Boring locations are shown on the drawings.

## 1.2 CHARACTER OF MATERIALS

The soil boring data are included in the drawing set for information only. Each log is believed to show the nature of the materials encountered at that specific location and to the depth indicated on the log; conditions vary between explorations. The boring logs and construction experience indicate that proper drainage is required for all excavations and earthwork; dewatering shall be expected for utility and other excavations extending 5 feet below existing grades during dry periods, and at any depth during and after rainy periods. Unstable soil conditions, resulting in delay to construction activity, shall also be expected during and after rainy periods.

## 1.3 BORING NOTES

## 1.3.1 Soils

Soils (ML, CL, GP, etc.) are classified in accordance with ASTM D-2487, Classification of Soils for Engineering Purposes. Soils are described in the field in accordance with ASTM D-2488 Description and Identification of Soils (Visual-Manual Procedure).

## 1.3.2 SPT Borings B-1 through B-14

Borings B-1 through B-14 were performed in accordance with the Standard Penetration Test (SPT) method as described by ASTM D-1586, Penetration Test and Split-Barrel Sampling of Soils. SPT data indicates depth of a sample and number of blows required to drive a 2 inch (50 mm) O.D. split spoon sampler 12 inch (300 mm) after a 6 inch (150 mm) seating interval, unless otherwise noted, into undisturbed soil with a 140 pound (0.625 kN) hammer falling 30 inches (0.75 meters). The standard penetration "N" value is the sum of the middle two 6-inch drives, when driving the split spoon sampler 24 inches.

## 1.3.2.1 Soils Consistencies

Soils consistencies can be estimated from the following tables, based upon the field-derived SPT data:

Relative Density of Gravels/Sands	
No. of Blows N	Relative Density
0-4	Very Loose

4-10	Loose
10-30	Medium
30-50	Dense
Over 50	Very Dense

Consistency of Clays/Silts,	
<u>No. of Blows N</u>	<u>Consistency</u>
0-2	Very Soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very Stiff
Over 30	Hard

### 1.3.3 Elevations

All elevation and locations are approximate.

### 1.3.4 Dates

Dates shown on logs are start and completion dates.

### 1.3.5 Samples

Samples are stored at the Engineering Consulting Services, Ltd office in Chesapeake, VA and are available for inspection.

PART 2 PRODUCTS NOT USED.

PART 3 EXECUTION NOT USED.

-- End of Section --

## SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS  
03/98

## PART 1 GENERAL

## 1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the sponsoring organization, e.g. UL 1 (1993; Rev thru Jan 1995) Flexible Metal Conduit. However, when the sponsoring organization has not assigned a number to a document, an identifying number has been assigned for convenience, e.g. UL's unnumbered 1995 edition of their Building Materials Directory is identified as UL-01 (1995) Building Materials Directory. The sponsoring organization number (UL 1) can be distinguished from an assigned identifying number (UL-1) by the dash mark (-).

## 1.2 ORDERING INFORMATION

The addresses of the organizations whose publications are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the sponsoring organization should be ordered from the source by title rather than by number.

AGRICULTURAL MARKETING SERVICE (AMS)  
Seed Regulatory and Testing Branch  
USDA, AMS, LS Div.  
Bldg. 506, BARC-East  
Soil Conservation Rd.  
Beltsville, MD 20705  
Ph: 301-504-9430

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)  
4301 Fairfax Dr., Suite 425  
ATTN: Pubs Dept.  
Arlington, VA 22203  
Ph: 703-524-8800  
Fax: 703-528-3816  
Internet E-Mail: ari@dgsys.com

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)  
1712 New Hampshire Avenue, NW  
Washington, DC 20009  
Ph: 202-483-9370  
FAX: 202-234-4721

AIR DIFFUSION COUNCIL (ADC)  
11 S. LaSalle St., Suite 1400  
Chicago, IL 60603  
Ph: 312-201-0101

Fax: 312-201-0214

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)  
30 W. University Dr.  
Arlington Heights, IL 60004-1893  
Ph: 708-394-0404  
Fax: 708-253-0088

ALUMINUM ASSOCIATION (AA)  
Pubs Department  
P.O. Box 753  
Waldorf, MD 20601  
Ph: 301-645-0756  
Fax: 301-843-0159

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)  
1540 East Dundee Rd., Suite 310  
Palatine, IL 60067-8321  
Ph: 708-202-1350  
Fax: 708-202-1480

AMERICAN ASSOCIATION OF NURSERYMEN (AAN)  
1250 I St., NW, Suite 500  
Washington, DC 20005  
Ph: 202-789-2900  
FAX: 202-789-1893

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)  
444 N. Capital St., NW, Suite 249  
Washington, DC 20001  
Ph: 202-624-5800  
Fax: 202-624-5806

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)  
P.O. Box 12215  
Research Triangle Park, NC 27709-2215  
Ph: 919-549-8141  
Fax: 919-549-8933

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)  
1200 19th Street NW, Suite 300  
Washington, DC 20036-4303  
Ph: 202-429-5155  
Fax: 202-223-4579

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA)  
950 N. Glebe Rd., Suite 160  
Arlington, VA 22203-1824  
Ph: 703-522-7350  
Fax: 703-522-2665

ACI INTERNATIONAL (ACI)  
P.O. Box 9094  
Farmington Hills, MI 48333  
Ph: 313-532-2600  
Fax: 313-533-4747

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

8618 Westwood Center Drive, Suite 105  
Vienna, VA 22182  
Ph: 703-821-1990  
Fax: 703-821-3054

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)  
1330 Camper Meadow Dr.  
Cincinnati, OH 45240  
Ph: 513-742-2020  
Fax: 513-742-3355

AMERICAN FOREST & PAPER ASSOCIATION (AFPA)  
1111 Nineteenth St. NW, Suite 800  
Washington, DC 20036  
Ph: 202-463-2733  
Fax: 202-463-2791

AMERICAN GAS ASSOCIATION (AGA)  
1515 Wilson Blvd.  
Arlington, VA 22209  
Ph: 703-841-8556  
Fax: 703-841-8406

AMERICAN GAS ASSOCIATION LABORATORIES (AGAL)  
8501 East Pleasant Valley Rd.  
Cleveland, OH 44131  
Ph: 216-524-4990  
Fax: 216-642-3463

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)  
1500 King St., Suite 201  
Alexandria, VA 22314-2730  
Ph: 703-684-0211  
Fax: 703-684-0242

AMERICAN HARDBOARD ASSOCIATION (AHA)  
1210 W. Northwest Highway  
Palatine, IL 60067  
Ph: 708-934-8800  
Fax: 708-934-8803

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)  
One E. Wacker Dr., Suite 3100  
Chicago, IL 60601-2001  
Ph: 312-670-2400  
Fax: 312-670-5403

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)  
7012 So. Revere Parkway, Suite 140  
Englewood, CO 80112  
Ph: 303-792-5592  
Fax: 303-792-0669

AMERICAN IRON AND STEEL INSTITUTE (AISI)  
1101 Seventeenth St., NW, Suite 1300  
Washington, DC 20036  
Ph: 202-452-7100  
Fax: 202-463-6573

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)  
11 West 42nd St  
New York, NY 10036  
Ph: 212-642-4900  
Fax: 212-302-1286

AMERICAN PETROLEUM INSTITUTE (API)  
1220 L St., NW  
Washington, DC 20005  
Ph: 202-682-8375  
Fax: 202-962-4776

AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)  
50 F St., NW, Suite 7702  
Washington, DC 20001  
Ph: 202-639-2190  
Fax: 202-639-2183

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)  
1711 Arlingate Lane  
P.O. Box 28518  
Columbus, OH 43228-0518  
Ph: 800-222-2768  
Fax: 614-274-6899

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)  
1916 Race St.  
Philadelphia, PA 19103  
Ph: 215-299-5585  
Fax: 215-977-9679

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)  
United Engineering Center  
345 East 47th St.  
New York, NY 10017-2398  
Ph: 800-548-2723  
Fax: 212-705-7300

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)  
1791 Tullie Cir., NE  
Atlanta, GA 30329-2305  
Ph: 404-636-8400 Fax: 404-321-5478

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)  
22 Law Dr., Box 2300  
Fairfield, NJ 07007-2900  
Ph: 800-843-2763  
Fax: 201-882-1717

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)  
P.O. Box 40362  
Bay Village, OH 44140  
Ph: 216-835-3040  
Fax: 216-835-3488

AMERICAN WATER WORKS ASSOCIATION (AWWA)  
6666 West Quincy  
Denver, CO 80235

Ph: 800-926-7337  
Fax: 303-795-1989

AMERICAN WELDING SOCIETY (AWS)  
550 N.W. LeJeune Road  
Miami, FL 33126  
Ph: 800-443-9353  
Fax: 305-443-7559

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)  
P.O. Box 286  
Woodstock, MD 21163-0286  
Ph: 410-465-3169  
Fax: 410-465-3195

APA-ENGINEERED WOOD ASSOCIATION (APA)  
7011 So. 19th Street  
P.O. Box 11700  
Tacoma, WA 98411-0700  
Ph: 206-565-6600  
Fax: 206-565-7265

ARCHITECTURAL WOODWORK INSTITUTE (AWI)  
13924 Braddock Road  
Centreville, VA 22020  
Ph: 703-222-1100  
Fax: 703-222-2499

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)  
1745 Jefferson Davis Highway, Suite 406  
Arlington, VA 22202  
Ph: 703-412-1153  
Fax: 703-412-1152

ASM INTERNATIONAL (ASM)  
Materials Park, OH 44073-0002  
Ph: 216-338-5151

ASPHALT INSTITUTE (AI)  
Research Park Dr.  
P.O. Box 14052  
Lexington, KY 40512-4052  
Ph: 606-288-4960  
Fax: 606-288-4999

ASSOCIATED AIR BALANCE COUNCIL (AABC)  
1518 K St., NW  
Washington, DC 20005  
Ph: 202-737-0202  
Fax: 202-638-4833

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)  
600 No. 18th St.  
P.O. Box 2641  
Birmingham, AL 35291-0992  
Ph: 205-250-2530  
Fax: 205-250-2540

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS (AHAM)

20 No. Wacker Dr., Suite 1500  
Chicago, IL 60606  
Ph: 312-984-5800  
Fax: 312-984-5823

BELLCORE (BELLCORE)  
ATTN: Customer Service  
8 Corporate Place  
Piscataway, NJ 08854  
Ph: 800-521-2673  
or  
908-699-2000  
FAX: 908-336-2559

BRICK INSTITUTE OF AMERICA (BIA)  
11490 Commerce Park Dr., Suite 308  
Reston, VA 22091-1525  
Ph: 703-620-0010  
Fax: 703-620-3928

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)  
355 Lexington Ave.  
New York, NY 10017  
Ph: 212-661-4261  
FAX: 212-370-9047

BUILDING OFFICIALS & CODE ADMINISTRATORS INTERNATIONAL (BOCA)  
4051 W. Flossmoor Rd.  
Country Club Hills, IL 60478-5795  
Ph: 708-799-2300  
Fax: 708-799-4981  
E-Mail: boca@aecnet.com

BUREAU OF RECLAMATION (BOR)  
Dept. of the Interior  
P.O. Box 25007  
Denver, CO 80225  
Ph: 303-236-6741

BUSINESS AND INSTITUTIONAL FURNITURE MANUFACTURERS ASSOCIATION  
(BIFMA)  
2680 Horizon Drive SE, Suite A-1  
Grand Rapids, MI 49546  
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Fax: 901-346-2233

SOUTHERN PINE INSPECTION BUREAU (SPIB)  
4709 Scenic Highway  
Pensacola, FL 32504-9094  
Ph: 904-434-2611  
Fax: 904-433-5594

STEEL DECK INSTITUTE (SDI)  
P.O. Box 9506  
Canton, OH 44711  
Ph: 216-493-7886  
Fax: 216-493-7928

STEEL DOOR INSTITUTE (SDOI)  
30200 Detroit Rd.  
Cleveland, OH 44145-1967  
Ph: 216-899-0010  
Fax: 216-892-1404

STEEL JOIST INSTITUTE (SJI)  
1205 Forty-eighth Ave. No., Suite A  
Myrtle Beach, SC 29577-5424  
Ph: 803-449-0487  
Fax: 803-449-1343

STEEL STRUCTURES PAINTING COUNCIL (SSPC)  
40 24th Street, 6th Floor  
Pittsburgh, PA 15222-4643  
Ph: 412-281-2331

Fax: 412-281-9992

STEEL TANK INSTITUTE (STI)  
570 Oakwood Rd.  
Lake Zurich, IL 60047  
Ph: 708-438-0989  
800-275-1300  
Fax: 708-438-4509

STEEL WINDOW INSTITUTE (SWI)  
1300 Summer Ave.  
Cleveland, OH 44115-2851  
Ph: 216-241-7333  
Fax: 216-241-0105

TILE COUNCIL OF AMERICA (TCA)  
P.O. Box 1787  
Clemson, SC 29633-1787  
Ph: 864-646-8453  
Fax: 864-646-2821

TRUSS PLATE INSTITUTE (TPI)  
583 D'Onofrio Dr., Suite 200  
Madison, WI 53719  
Ph: 608-833-5900  
Fax: 608-833-4360

UNDERWRITERS LABORATORIES (UL)  
333 Pfingsten Rd.  
Northbrook, IL 60062-2096  
Ph: 800-704-4050  
Fax: 847-509-6249

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)  
2655 Villa Creek Dr., Suite 155  
Dallas, TX 75234  
Ph: 214-243-3902  
Fax: 214-243-3907

U.S. CONSUMER PRODUCT SAFETY COMMISSION (USCPSC)  
Washington, DC 20207  
Ph: 301-504-0580

WATER QUALITY ASSOCIATION (WQA)  
4151 Naperville Rd.  
Lisle, IL 60532  
Ph: 708-505-0160  
Fax: 708-505-9637

WELDING RESEARCH COUNCIL (WRC)  
345 East 47th St.  
New York, NY 10017  
Ph: 212-705-7956  
Fax: 212-371-9622

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)  
P.O. Box 23145  
Portland, OR 97281  
Ph: 503-639-0651

Fax: 503-684-8928

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

Yeon Bldg.

522 SW 5th Ave.

Portland, OR 97204-2122

Ph: 503-224-3930

Fax: 503-224-3934

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMPA)

P.O. Box 25278

Portland, OR 97225

Ph: 503-292-9288

PART 2 NOT USED

PART 3 NOT USED

-- End of Section --

SECTION 01111  
SAFETY AND HEALTH REQUIREMENTS  
07/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ENGINEERING MANUALS

EM 385-1-1 (1996) Safety and Health Requirements Manual

## CODE OF FEDERAL REGULATIONS

29 CFR 1910 Occupational Safety and Health Standards,  
General Industry.

29 CFR 1926 Occupational Safety and Health Standards,  
Construction Industry.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-07 Certificates

Safety and Health Plan (Accident Prevention Plan); G

Designated first-aid and CPR trained attendants; G

## 1.3 SAFETY REQUIREMENTS AND ACCIDENT PREVENTION

## 1.3.1 Standards

The Contractor shall comply with Occupational Safety and Health Act (OSHA) Standards, the Corps of Engineers Manual EM 385-1-1, "Safety and Health Requirements Manual," NFPA 101, and all applicable state, local, and facility safety and occupational health requirements.

## 1.4 SAFETY AND HEALTH PLAN

## 1.4.1 Preparation and Implementation

An Accident Prevention Plan (APP) shall be prepared covering onsite work to be performed by the Contractor and all subcontractors, and shall at a minimum address the requirements for an Accident Prevention Plan (APP), as contained in Appendix A, EM 385-1-1. The Contractor shall designate in writing a Safety and Health Manager who shall be responsible for the development, implementation and continual oversight of the APP. The APP

shall establish, in detail, the protocols necessary for the anticipation, recognition, evaluation, and control of hazards associated with each task to be performed. The APP shall address general safety and health requirements and procedures. The level of detail provided in the APP shall be tailored to the type of work, complexity of operations, and the anticipated hazards to be encountered. Details about some activities may not be available when the initial APP is prepared and submitted. Therefore, the APP shall address, in as much detail as possible, all anticipated tasks, their related hazards and the specific control measures to be instituted.

#### 1.4.2 Acceptance and Modifications

Prior to submittal, the APP shall be signed and dated by the Contractor's designated Safety and Health Manager, Project Manager, and the Site Superintendent. The APP shall be submitted for review at least 10 days prior to the Pre-work Safety Conference. Deficiencies in the APP will be discussed at the Pre-work Safety Conference, and the APP shall be revised to correct the deficiencies and resubmitted for acceptance. Onsite work shall not begin until the plan has been accepted. A copy of the written APP shall be maintained onsite. Once accepted by the Contracting Officer, the Accident Prevention Plan, including Activity Hazard Analyses and all applicable plans, programs and procedures required by the Safety Manual (EM 385-1-1), will be enforced as if an addition to the contract. As work proceeds, the APP shall be adapted to new situations and new conditions. Changes and modifications to the accepted APP shall be made with the knowledge and concurrence of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer. Should any unforeseen hazard become evident during the performance of the work, such hazards shall be brought to the attention of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer, both verbally and in writing, for satisfactory resolution as soon as possible. In the interim, all necessary action shall be taken to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of this specification or the accepted APP shall be cause for stopping of work until the matter has been resolved and rectified to the satisfaction of the Contracting Officer.

#### 1.4.3 Activity Hazard Analysis (AHA)

Activity Hazard Analyses (AHA) for each major phase of work shall be submitted and updated during the project. Each Activity Hazard Analysis shall be prepared and submitted in accordance the requirements and format provided for in EM 385-1-1 (Figure 1-1), and shall be accepted as an Appendix to the project APP. The AHA shall define the activities to be performed for each major phase of work, identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not proceed on that phase until the AHA has been accepted and a preparatory meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activities, including the onsite Government representatives. The Activity Hazard Analyses shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations.

#### 1.5 Hazard Communication Program

A hazard communication program shall be established and implemented in accordance with 29 CFR 1926, Section .59. Material safety data sheets

(MSDSs) shall be provided for all hazardous materials brought onto the worksite. One copy shall be provided to the Contracting Officer and 1 copy shall be included in the Contractor's Hazard Communication Program.

#### 1.5.1 Corps of Engineers Standards

Corps of Engineers Manual EM 385-1-1, referred to in "ACCIDENT PREVENTION" article of Contract Clauses, is hereby supplemented or revised as follows:

##### 1.5.1.1 Conflicts

When a conflict exists between the Corps of Engineers Safety and Health Requirements Manual, other safety requirements, or the contract plans and/or specifications, the most stringent requirement shall prevail, as determined by the Contracting Officer.

##### 1.5.1.2 Front End Loader - Backhoe Machines

###### 1.5.1.2.# Non-compliance Safety Check

All front end loader-backhoe machines and other machines, such as tractors that utilize a backhoe attachment, shall be checked for:

- a. Exposed backhoe boom swing foot pedals.
- b. Backhoe boom swing lever which can be reached by a man standing on the ground or on the outrigger support bracket.

###### 1.5.1.2.# Correction and Fabrication of Non-compliance Safety Items

Where these conditions exist, guards shall be fabricated to:

- a. Cover over exposed foot pedals to prevent someone from accidentally stepping on them.
- b. Enclose the swing lever so as to preclude operation from the ground or from the outrigger support bracket.

##### 1.5.1.3 Attendance at Safety Meetings

In order to allow for maximum attendance at weekly tool box safety meetings and monthly supervisor safety meetings by Corps of Engineers personnel, the Contractor shall advise the CO's Office, a minimum of 48 hours before the start of each meeting, of the date, time and location of Safety Meetings.

##### 1.5.1.4 Minutes of Safety Meetings

Minutes shall be prepared by the Contractor and forwarded to the Contracting Officer by close of business of the next working day.

##### 1.5.1.5 Protective Footwear

Protective footwear shall be worn by all personnel working on site. Such protective footwear shall be approved by the American National Standards Institute (ANSI), and shall be constructed and tested in accordance with the requirements of ANSI Standard Z41. Footwear providing protection against impact and compression hazards shall at least be rated as I75 and C75.

## 1.5.1.6 Head Protection

All construction areas are to be designated as hard hat areas, and shall be identified and appropriately posted as such. All protective headgear (hard hats) shall meet the requirements of ANSI Standard Z89.1. All personnel working in or visiting hard hat areas shall be provided with and required to wear Class A (low voltage electrical protection) or Class B (high voltage electrical protection) protective headgear.

## 1.5.1.7 Ground Fault Circuit Interrupters (GFCI)

GFCI's are required for work on this contract in accordance with EM 385-1-1. GFCI's are also required when using electric power extension cords.

## 1.5.1.8 Crawler-, Truck-, and Wheel-Mounted Cranes

Implementation of paragraph 16.D.05 shall include the following:

a. When a crane is performing duty cycle work (such as clamshell, dragline, grapple, or pile driving) it does not require anti-two block equipment. If the crane is required to make a non-duty cycle lift (for example, to lift a piece of equipment, a tool box, or supplies), it will be exempt from the anti-two block equipment requirements if the following procedures are implemented:

- (1) an international orange warning device (warning flag, warning tape, or warning ball) is properly secured to the hoist line at a distance of 8 to 10 feet above the hoist rigging;
- (2) the signal person (or an individual designated as the signal person) acts as a spotter to alert the crane operator with a "STOP" signal when the warning device approaches the boom tip and the crane operator ceases hoisting functions when alerted of this; and
- (3) while the non-duty cycle lift is underway, the signal person shall not stand under the load, shall have no duties other than signal person, and shall comply with the signaling requirements of EM 385-1-1;

b. Anti-two block devices are always required when hoisting personnel by crane or derrick.

## 1.5.1.9 Designated First-aid and CPR Trained Attendants

The Contractor shall designate at least 2 persons who are currently trained in first aid and CPR by the American Red Cross or other approved agency for each work shift, and these individuals shall be onsite at all times during site operations. They shall be trained in universal precautions and the use of PPE as described in the Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030 and shall be included in the Contractor's Bloodborne Pathogen Program. These persons may perform other duties but shall be immediately available to render first aid when needed. A copy of each designated person's current valid First Aid and CPR certificate shall be provided.

PART 2 PRODUCTS (THIS PART NOT USED)

PART 3 EXECUTION (THIS PART NOT USED)

-- End of Section --



## SECTION 01200

## PROJECT MEETINGS

07/00

## PART 1 GENERAL

## 1.1 SUBMITTALS (NOT APPLICABLE)

## 1.2 PRECONSTRUCTION CONFERENCE

## 1.2.1 Scheduling

After award of the construction contract and prior to the start of any construction work, the Contracting Officer (CO) will schedule and conduct a preconstruction conference. The Contractor's Project Manager, Superintendent and Quality Control System Manager shall attend this meeting. The Contractor is encouraged to have an officer of his company (Project Manager could be this person) and representation from each of his sub-contractors at the conference. This conference will be held at a location and time as specified by the CO.

## 1.2.2 Purpose

The purpose of this preconstruction conference is to enable the CO to outline the procedures that will be followed by the Government in its administration of this construction contract and to discuss the performance that will be expected from the Contractor. This conference will allow the Contractor an opportunity to ask questions about the Government's supervision and inspection of contract work, about security requirements, regulations, etc. The CO may invite Using Service personnel and any other Government personnel to attend this conference.

## 1.2.3 Discussion Items

The following is a list of items for discussion during the preconstruction conference. However, the Contracting Officer may include additional items for discussion as conditions and the work require.

- a. Authority of the Area/Resident Engineer and organization of the Area/Resident office.
- b. Contractor's Progress Schedule.
- c. Correspondence Procedures.
- d. Contractor Labor Standards Provisions.
- e. Contract Modifications and Administrative Procedures.
- f. Contractor's Administrative, Laydown and Storage Areas.
- g. Procedures for Processing Submittals.
- h. Payment Estimate Data and Procedures.

- i. Contractor Utilities.
- j. Security Requirements and Other Regulations, if applicable.
- k. Government Furnished Equipment, if applicable.
- l. Disposition of Salvage Property.
- m. Contractor Insurance Requirements.
- n. Value Engineering Program.
- o. Contractor Performance Evaluation.
- p. As-Built Drawings.
- q. Warranty of Construction and Single Point of Contact.
- r. Turnover of Completed Facilities.

### 1.3 OTHER MEETINGS

Other meetings may be held after the Preconstruction Conference, and such meetings may include the following:

- a. Accident Prevention Safety Plan
- b. Quality Control Plan.
- c. Environmental Protection Plan.
- d. Warranty Management Plan.
- e. Red-Zone Meeting.

### 1.4 FACILITY MEETINGS

The Facility may also schedule meetings with the Contractor through the CO during the progress of construction work.

### 1.5 MINUTES OF MEETINGS

The Government will prepare minutes of the meeting and will provide the Contractor with a signed original for review and concurrence. The minutes shall include all items discussed at the meeting and the Government will make all corrections provided by the Contractor and resubmit the corrected minutes to the Contractor within seven days.

PART 2 PRODUCTS (THIS PART NOT USED)

PART 3 EXECUTION (THIS PART NOT USED)

-- End of Section --

## SECTION 01312

## RESIDENT MANAGEMENT SYSTEM (RMS)

07/00

## PART 1 GENERAL

## 1.1 GENERAL

The Government will use the Resident Management System for Windows (RMS-W) to assist in its monitoring and administration of this contract. The Contractor shall use the Government-furnished Construction Contractor Module of RMS-Windows, referred to as RMS-QC (QC for Quality Control), to record, maintain, and submit various information throughout the contract period. This joint Government-Contractor use of RMS-W and RMS-QC will facilitate electronic exchange of information and overall management of the contract. RMS-QC provides the means for the Contractor to input, track, and electronically share information with the Government in the following areas:

- Administration
- Finances
- Quality Control
- Submittal Monitoring
- Scheduling
- Import/Export of Data

## 1.2 CORRESPONDENCE AND ELECTRONIC COMMUNICATIONS

For ease and speed of communications, both Government and Contractor will, to the maximum extent feasible, exchange correspondence and other documents in electronic format. Correspondence, pay requests and other documents comprising the official contract record shall also be provided in paper format, with signatures and dates where necessary. Paper documents will govern, in the event of discrepancy with the electronic version.

## 1.3 OTHER FACTORS

Particular attention is directed to Contract Clause, "Schedules for Construction Contracts", Contract Clause, "Payments", Section 01320, "Project Schedule", Section 01330, SUBMITTAL PROCEDURES, and Section 01451, CONTRACTOR QUALITY CONTROL, which have a direct relationship to the reporting to be accomplished through RMS-QC. Also, there is no separate payment for establishing and maintaining the RMS-QC database; all costs associated therewith shall be included in the contract pricing for the work.

## 1.4 RMS-QC SOFTWARE

RMS-QC is a Windows-based program that can be run on a stand-alone personal computer or on a network. The Government will make available the RMS-QC software to the Contractor after award of the construction contract. Prior to the Pre-Construction Conference, the Contractor shall be responsible to download, install and use the latest version of the RMS-QC software from the Government's RMS Internet Website. Upon specific justification, request by the Contractor, and approval by the Contracting Officer, the Government can provide RMS-QC on 3-1/2" high-density diskettes or CD-ROM. Any program updates of RMS-QC will be made available to the Contractor via

the Government RMS Website as they become available.

#### 1.5 SYSTEM REQUIREMENTS

The following listed hardware and software is the minimum system configuration that the Contractor shall have to run RMS-QC:

##### **Hardware**

IBM-compatible PC with 200 MHz Pentium or higher processor

32+ MB RAM

4 GB hard drive disk space for sole use by the RMS-QC system

3 1/2 inch high-density floppy drive

Compact disk (CD) Reader

Color monitor

Laser printer compatible with HP LaserJet III or better, with minimum 4 MB installed memory.

Connection to the Internet, minimum 28 BPS

##### **Software**

Microsoft (MS) Access 97 or newer version database software

MS Windows 95 or newer version operating system (MS Windows NT 4.0 or newer is recommended)

Word Processing software compatible with MS Word 97 or newer

Internet browser

The Contractor's computer system shall be protected by virus protection software that is regularly upgraded with all issued manufacturer's updates throughout the life of the contract.

Electronic mail (E-mail) compatible with MS Outlook

#### 1.6 RELATED INFORMATION

#### 1.7 RMS-QC USER GUIDE

After contract award, the Contractor shall download instructions for the installation and use of RMS-QC from the Government RMS Internet Website; the Contractor can obtain the current address from the Government. In case of justifiable difficulties, the Government will provide the Contractor with a CD-ROM containing these instructions.

#### 1.8 CONTRACTOR QUALITY CONTROL(CQC) TRAINING

The use of RMS-QC will be discussed with the Contractor's QC System Manager during the mandatory training entitled "Construction Quality Management For Contractors". In addition, informal training sessions on use of the QC RMS program are conducted periodically and offered by the Corps of Engineers.

Specific times and locations are available from the Contracting Officer.

#### 1.9 CONTRACT DATABASE

Prior to the pre-construction conference, the Government shall provide the Contractor with basic contract award data to use for RMS-QC. The Government will provide data updates to the Contractor as needed, generally by files attached to E-mail. These updates will generally consist of submittal reviews, correspondence status, QA comments, and other administrative and QA data.

#### 1.10 DATABASE MAINTENANCE

The Contractor shall establish, maintain, and update data for the contract in the RMS-QC database throughout the duration of the contract. The Contractor shall establish and maintain the RMS-QC database at the Contractor's site office. Data updates to the Government shall be submitted by E-mail with file attachments, e.g., daily reports, schedule updates, payment requests. If permitted by the Contracting Officer, a data diskette or CD-ROM may be used instead of E-mail (see Paragraph DATA SUBMISSION VIA COMPUTER DISKETTE OR CD-ROM). The RMS-QC database typically shall include current data on the following items:

#### 1.11 ADMINISTRATION

##### 1.11.1 Contractor Information

The database shall contain the Contractor's name, address, telephone numbers, management staff, and other required items. Within 14 calendar days of receipt of RMS-QC software from the Government, the Contractor shall deliver Contractor administrative data in electronic format via E-mail.

##### 1.11.2 Subcontractor Information

The database shall contain the name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor must be listed separately for each trade to be performed. Each subcontractor/trade shall be assigned a unique Responsibility Code, provided in RMS-QC. Within 14 calendar days of receipt of RMS-QC software from the Government, the Contractor shall deliver subcontractor administrative data in electronic format via E-mail.

##### 1.11.3 Correspondence

All Contractor correspondence to the Government shall be identified with a serial number. Correspondence initiated by the Contractor's site office shall be prefixed with "S". Letters initiated by the Contractor's home (main) office shall be prefixed with "H". Letters shall be numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C".

#### 1.12 FINANCES

##### 1.12.1 Pay Activity Data

The RMS-QC database shall include a list of pay activities that the Contractor shall develop in conjunction with the construction schedule. The sum of all pay activities shall be equal to the total contract amount,

including modifications. Pay activities shall be grouped by Contract Line Item Number (CLIN), and the sum of the activities shall equal the amount of each CLIN. The total of all CLINs equals the Contract Amount.

#### 1.12.2 Payment Requests

All progress payment requests shall be prepared using RMS-QC. The Contractor shall complete the payment request worksheet and include it with the payment request. The work completed under the contract, measured as percent or as specific quantities, shall be updated at least monthly. After the update, the Contractor shall generate a payment request report using RMS-QC. The Contractor shall submit the payment requests with supporting data by E-mail with file attachment(s). If permitted by the Contracting Officer, a data diskette may be used instead of E-mail. A signed paper copy of the approved payment request is also required, which shall govern in the event of discrepancy with the electronic version.

#### 1.13 QUALITY CONTROL (QC)

RMS-QC provides a means to track implementation of the 3-phase QC Control System, prepare daily reports, identify and track deficiencies, document progress of work, and support other contractor QC requirements. The Contractor shall maintain this data on a daily basis. Entered data will automatically output to the RMS-QC generated daily report. The Contractor shall provide the Government a Contractor Quality Control (CQC) Plan within the time required in Section 01451, CONTRACTOR QUALITY CONTROL. Within seven calendar days of Government acceptance, the Contractor shall submit a data diskette or CD-ROM reflecting the information contained in the accepted CQC Plan: schedule, pay activities, features of work, submittal register, QC requirements, and equipment list.

##### 1.13.1 Daily Contractor Quality Control (CQC) Reports.

RMS-QC includes the means to produce the Daily CQC Report. The Contractor may use other formats to record basic QC data. However, the Daily CQC Report generated by RMS-QC shall be the Contractor's official report. Data from any supplemental reports by the Contractor shall be summarized and consolidated onto the RMS-QC-generated Daily CQC Report. Daily CQC Reports shall be submitted as required by Section 01451, CONTRACTOR QUALITY CONTROL. Reports shall be submitted electronically to the Government using E-mail or diskette within 24 hours after the date covered by the report. Use of either mode of submittal shall be coordinated with the government representative. The Contractor shall also provide the Government a signed, printed copy of the daily CQC report.

##### 1.13.2 Deficiency Tracking.

The Contractor shall use RMS-QC to track deficiencies. Deficiencies identified by the Contractor will be numerically tracked using QC Comments.

The contractor shall maintain a current log of its QC comments in the RMS-QC database. The Government will log the deficiencies it has identified using its QA comments. The Government's QA comments will be included in its export file to the Contractor. The Contractor shall regularly update the correction status of both QC and QA comments.

##### 1.13.3 Three-Phase Control Meetings

The Contractor shall maintain scheduled and actual dates and times of preparatory and initial control meetings in RMS-QC.

#### 1.13.4 Accident/Safety Tracking.

The Government will issue safety comments, directions, or guidance whenever safety deficiencies are observed. The Government's safety comments will be included in its export file to the Contractor. The Contractor shall regularly update the correction status of the safety comments. In addition, the Contractor shall utilize RMS-QC to advise the Government of any accidents occurring on the jobsite. This brief supplemental entry is not to be considered as a substitute for completion of mandatory reports, e.g., ENG Form 3394 and OSHA Form 200.

#### 1.13.5 Features of Work

The Contractor shall include a complete list of the features of work in the RMS-QC database. A feature of work may be associated with multiple pay activities. However, each pay activity (see subparagraph "Pay Activity Data" of paragraph "Finances") will only be linked to a single feature of work.

#### 1.13.6 QC Requirements

The Contractor shall develop and maintain a complete list of QC testing, transferred and installed property, and user training requirements in RMS-QC. The Contractor shall update all data on these QC requirements as work progresses, and shall promptly provide this information to the Government via RMS-QC.

#### 1.14 SUBMITTAL MANAGEMENT

The Government will provide the initial submittal register, ENG Form 4288, SUBMITTAL REGISTER, in electronic format. Thereafter, the Contractor shall maintain a complete list of all submittals, including completion of all data columns as described in Section 01330, SUBMITTAL PROCEDURES. Dates on which submittals are received and returned by the Government will be included in its export file to the Contractor. The Contractor shall use RMS-QC to track and transmit all submittals. ENG Form 4025, submittal transmittal form, and the submittal register update, ENG Form 4288, shall be produced using RMS-QC. RMS will be used to update, store and exchange submittal registers and transmittals, but will not be used for storage of actual submittals.

#### 1.15 SCHEDULE

The Contractor shall develop a construction schedule consisting of pay activities, in accordance with Contract Clause "Schedules for Construction Contracts", and Section 01320, PROJECT SCHEDULE, as applicable. This schedule shall be input and maintained in the RMS-QC database either manually or by using the Standard Data Exchange Format (SDEF) (see Section 01320 PROJECT SCHEDULE). The updated schedule data shall be included with each pay request submitted by the Contractor.

#### 1.16 IMPORT/EXPORT OF DATA

RMS-QC includes the ability to export Contractor data to the Government and to import submittal register and other Government-provided data, and schedule data using SDEF.

#### 1.17 IMPLEMENTATION

Contractor use of RMS-QC as described in the preceding paragraphs is mandatory. The Contractor shall ensure that sufficient resources are available to maintain its RMS-QC database, and to provide the Government with regular database updates. RMS-QC shall be an integral part of the Contractor's management of quality control.

#### 1.18 DATA SUBMISSION VIA COMPUTER DISKETTE OR CD-ROM

The Government-preferred method for Contractor's submission of updates, payment requests, correspondence and other data is by E-mail with file attachment(s). For locations where this is not feasible, the Contracting Officer may permit use of computer diskettes or CD-ROM for data transfer. Data on the disks or CDs shall be exported using the RMS-QC built-in export function. If used, diskettes and CD-ROMs will be submitted in accordance with the following:

#### 1.19 FILE MEDIUM

The Contractor shall submit required data on 3-1/2" double-sided high-density diskettes formatted to hold 1.44 MB of data, capable of running under Microsoft Windows 95 or newer. Alternatively, CD-ROMs may be used. They shall conform to industry standards used in the United States. All data shall be provided in English.

#### 1.20 DISK OR CD-ROM LABELS

The Contractor shall affix a permanent exterior label to each diskette and CD-ROM submitted. The label shall indicate in English, the RMS-QC file name, full contract number, project name, project location, data date, name and telephone number of person responsible for the data.

#### 1.21 FILE NAMES

The Government will provide the file names to be used by the Contractor with the RMS-QC software.

#### 1.22 MONTHLY COORDINATION MEETING

The Contractor shall update the RMS-QC database each workday. At least monthly, the Contractor shall generate and submit an export file to the Government with schedule update and progress payment request. As required in Contract Clause "Payments", at least one week prior to submittal, the contractor shall meet with the Government representative to review the planned progress payment data submission for errors and omissions. The contractor shall make all required corrections prior to Government acceptance of the export file and progress payment request. Payment requests accompanied by incomplete or incorrect data submittals will be returned. The Government will not process progress payments until an acceptable RMS-QC export file is received.

## PART 2 PRODUCTS

### 2.1 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the requirements of this specification. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed

sufficient for the purpose of notification.

PART 3 EXECUTION

Not used.

-- End of Section --

## SECTION 01320

PROJECT SCHEDULE  
07/2000

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of the specification to the extent referenced. The publications are referenced in the text by basic designation only.

## ENGINEERING REGULATIONS (ER)

ER 1-1-11 (1995) Progress, Schedules, and Network Analysis Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Preconstruction Submittals

Initial Project Schedule; G. Preliminary Project Schedule; G. Periodic Schedule Updates; G.

Two copies of the schedules showing codes, values, categories, numbers, items, etc., as required.

## SD-07 Certificates

## Qualifications

Documentation showing qualifications of personnel preparing schedule reports.

## SD-09 Manufacturer's Field Reports

Narrative Report. Schedule Reports.

Three copies of the reports showing numbers, descriptions, dates, float, starts, finishes, durations, sequences, etc., as required.

## 1.3 QUALIFICATIONS

The Contractor shall designate an authorized representative who shall be responsible for the preparation of all required project schedule reports.

## PART 2 PRODUCTS (NOT APPLICABLE)

### PART 3 EXECUTION

#### 3.1 GENERAL REQUIREMENTS

Pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS, a Project Schedule as described below shall be prepared. The scheduling of construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used to measure the progress of the work, to aid in evaluating time extensions, and to provide the basis of all progress payments.

#### 3.2 STANDARD DATA EXCHANGE FORMAT (SDEF)

In collaboration with scheduling software vendors, construction management consultants, professional associations, and other Federal agencies, the U.S. Army Corps of Engineers Construction Engineering Research Laboratories (CERL) has facilitated the development of a Standard Data Exchange Format (SDEF) for scheduling software. This standard uses a 132-character fixed field; an ASCII file to specify the position, length, and definition of all required project planning and control information. Since most scheduling software can already export ASCII data, software vendors can easily revise existing export routines to provide the data in the SDEF. Several software vendors already support SDEF. Project schedule electronic data shall be provided in SDEF as described later in this section. The document "Contractor's Guide to Standard Data Exchange Format" is a general guide to SDEF and is available from the Contracting Officer to the successful bidder.

#### 3.3 RESIDENT MANAGEMENT SYSTEM (RMS)

Scheduling data shall be in SDEF. Scheduling software, capable of producing an SDEF file (standard data exchange format), shall electronically transfer activity data into the Resident Management System (RMS) Contractor Quality Control Module (RMS QC), see Section 01312, Resident Management System (RMS).

#### 3.4 BASIS FOR PAYMENT

The schedule shall be the basis for measuring Contractor progress. Lack of an approved schedule or scheduling personnel will result in an inability of the Contracting Officer to evaluate Contractor's progress for the purposes of payment. Failure of the Contractor to provide all information, as specified below, shall result in the disapproval of the entire Project Schedule submission and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. In the case where Project Schedule revisions have been directed by the Contracting Officer and those revisions have not been included in the Project Schedule, the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until revisions to the Project Schedule have been made.

#### 3.5 PROJECT SCHEDULE

The computer software system utilized by the Contractor to produce the Project Schedule shall be capable of providing all requirements of this specification. Failure of the Contractor to meet the requirements of this specification shall result in the disapproval of the schedule. Manual

methods used to produce any required information shall require approval by the Contracting Officer.

### 3.5.1 Use of the Critical Path Method

The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in the Precedence Diagram Method (PDM).

### 3.5.2 Level of Detail Required

The Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule. The Contracting Officer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Project Schedule:

#### 3.5.2.1 Activity Durations

Contractor submissions shall follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods (usually less than 2 percent of all non-procurement activities' Original Durations are greater than 20 days).

#### 3.5.2.2 Procurement Activities

Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, and delivery.

#### 3.5.2.3 Government Activities

Government and other agency activities that could impact progress shall be shown. These activities include, but are not limited to: approvals, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

#### 3.5.2.4 Responsibility

All activities shall be identified in the project schedule by the party responsible to perform the work. Responsibility includes, but is not limited to, the subcontracting firm, contractor work force, or government agency performing a given task. Activities shall not belong to more than one responsible party. The responsible party for each activity shall be identified by the Responsibility Code. The responsibility codes used must be coordinated with those used in RMS.

#### 3.5.2.5 Work Areas

For projects with separate work areas, all activities shall be identified in the project schedule by the work area in which the activity occurs. Activities shall not be allowed to cover more than one work area. The work area of each activity shall be identified by the Work Area Code.

### 3.5.2.6 Modification or Claim Number

Any activity that is added or changed by contract modification or used to justify claimed time shall be identified by a mod or claim code that changed the activity. Activities shall not belong to more than one modification or claim item. The modification or claim number of each activity shall be identified by the Mod or Claim Number. Whenever possible, changes shall be added to the schedule by adding new activities. Existing activities shall not normally be changed to reflect modifications.

### 3.5.2.7 Bid Item

All activities shall be identified in the project schedule by the Bid Item to which the activity belongs. An activity shall not contain work in more than one bid item. The bid item for each appropriate activity shall be identified by the Bid Item Code. The Bid Item Numbers used in the schedule must exactly match those in the RMS data disk provided by the Contracting Officer.

### 3.5.2.8 Phase of Work

For projects with separate phases of construction, all activities shall be identified in the project schedule by the phases of work in which the activity occurs. Activities shall not contain work in more than one phase of work. The project phase of each activity shall be by the unique Phase of Work Code.

### 3.5.2.9 Category of Work

All Activities shall be identified in the project schedule according to the category of work which best describes the activity. The category of work for each activity shall be identified by the Category of Work Code. The category of work codes must be coordinated with those used by RMS.

### 3.5.2.10 Feature of Work

All activities shall be identified in the project schedule according to the feature of work to which the activity belongs. Feature of work refers, but is not limited to, a work breakdown structure for the project. The feature of work for each activity shall be identified by the Feature of Work Code. Whenever possible, the feature of work title shall match those in RMS. Other features may be added if those in RMS do not adequately describe the work.

### 3.5.3 Scheduled Project Completion

The schedule interval shall extend from NTP to the contract completion date.

#### 3.5.3.1 Project Start Date

The schedule shall start no earlier than the date on which the NTP was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

#### 3.5.3.2 Constraint of Last Activity

Completion of the last activity in the schedule shall be constrained by the contract completion date. Calculation on project updates shall be such that if the early finish of the last activity falls after the contract completion date, then the float calculation shall reflect a negative float on the critical path. The Contractor shall include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

#### 3.5.3.3 Early Project Completion

In the event the project schedule shows completion of the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted in the narrative report at every project schedule update period to assist the Contracting Officer in evaluating the Contractor's ability to actually complete prior to the contract period.

#### 3.5.4 Interim Completion Dates

Contractually specified interim completion dates shall also be constrained to show negative float if the early finish date of the last activity in that phase falls after the interim completion date.

##### 3.5.4.1 Start Phase

The Contractor shall include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have an "ES" constraint date equal to the date on which the NTP was acknowledged, and a zero day duration.

##### 3.5.4.2 End Phase

The Contractor shall include as the last activity in a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have an "LF" constraint date equal to the completion date for the project, and a zero day duration.

##### 3.5.4.3 Phase X

The Contractor shall include a hammock type activity for each project phase called "Phase X" where "X" refers to the phase of work. The "Phase X" activity shall be logically tied to the earliest and latest activities in the phase.

#### 3.5.5 Default Progress Data Disallowed

Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual Start and Finish dates on the CPM schedule shall match those dates provided from those dates logged in RMS QC. Failure of the Contractor to document the Actual Start and Finish dates in RMS QC for every in-progress or completed activity, and failure to ensure that the data contained in RMS QC is the sole basis for schedule updating shall result in the disapproval of the Contractor's schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. Updating of the percent complete and the remaining duration of any activity shall be independent

functions. Program features which calculate one of these parameters from the other shall be disabled.

#### 3.5.6 Out-of-Sequence Progress

Activities that have posted progress without all preceding logic being satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case approval of the Contracting Officer. The Contractor shall propose logic corrections to eliminate all out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule.

#### 3.5.7 Negative Lags

Lag durations contained in the project schedule shall not have a negative value.

### 3.6 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data disk, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS.

#### 3.6.1 Preliminary Project Schedule Submission

The Preliminary Project Schedule, defining the Contractor's planned operations for the first 90 calendar days shall be submitted for approval within 15 calendar days after the NTP is acknowledged. The approved preliminary schedule shall be used for payment purposes not to exceed 90 calendar days after NTP. The Preliminary Project Schedule shall be prepared in the contractor's NAS scheduling software system and include subcontractor codes, features of work, and pay activities for the contractor's planned operations during the first 90 calendar days.

#### 3.6.2 Initial Project Schedule Submission

The Initial Project Schedule shall be submitted for approval within 45 calendar days after NTP. The schedule shall provide a reasonable sequence of activities which represent work through the entire project and shall be at a reasonable level of detail.

#### 3.6.3 Periodic Schedule Updates

Based on the result of progress meetings, specified in "Periodic Progress Meetings," the Contractor shall submit periodic schedule updates. These submissions shall enable the Contracting Officer to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgement of the Contracting Officer or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

#### 3.6.4 Standard Activity Coding Dictionary

The Contractor shall use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11, Appendix A. This exact structure is mandatory, even if some fields are not used. All codes must be carefully coordinated with those used in RMS.

### 3.7 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the preliminary submission, initial submission, and every periodic project schedule update throughout the life of the project:

#### 3.7.1 Data Disks

One data disk containing the project schedule shall be provided. Data on the disks shall adhere to the SDEF format specified in ER 1-1-11, Appendix A. Data disks required from RMS QC shall be provided in addition to this disk.

##### 3.7.1.1 File Medium

Required data shall be submitted on 3.5 disks, formatted to hold 1.44 MB of data, under the MS-DOS Version 5. or 6.x, unless otherwise approved by the Contracting Officer.

##### 3.7.1.2 Disk Label

A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Preliminary, Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number or person responsible for the schedule, and the MS-DOS version used to format the disk.

##### 3.7.1.3 File Name

Each file submitted shall have a name related to either the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will ensure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

#### 3.7.2 Narrative Report

A Narrative Report shall be provided with the preliminary, initial, and each update of the project schedule. This report shall be provided as the basis of the Contractor's progress payment request. The Narrative Report shall include: a description of activities along the 2 most critical paths, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to relay to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis.

#### 3.7.3 Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

#### 3.7.4 Schedule Reports

The format for each activity for the schedule reports listed below shall

contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float. Actual Start and Actual Finish Dates shall be printed for those activities in progress or completed.

#### 3.7.4.1 Activity Report

A list of all activities sorted according to activity number.

#### 3.7.4.2 Logic Report

A list of Preceding and Succeeding activities for every activity in ascending order by activity number. Preceding and succeeding activities shall include all information listed above in paragraph Schedule Reports. A blank line shall be left between each activity grouping.

#### 3.7.4.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates. Completed activities shall not be shown on this report.

#### 3.7.4.4 Earnings Report

A compilation of the Contractor's Total Earnings on the project from the NTP until the most recent Monthly Progress Meeting. This report shall reflect the Earnings of specific activities based on the agreements made in the field and approved between the Contractor and Contracting Officer at the most recent Monthly Progress Meeting. Provided that the Contractor has provided a complete schedule update, this report shall serve as the basis of determining Contractor Payment. Activities shall be grouped by bid item and sorted by activity numbers. This report shall: sum all activities in a bid item and provide a bid item percent; and complete and sum all bid items to provide a total project percent complete. The printed report shall contain, for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), and Earnings to Date. Reports from RMS QC, containing the information described above, may be provided in lieu of this report.

#### 3.7.5 Network Diagram

The network diagram shall be required on the initial schedule submission and on monthly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

##### 3.7.5.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows from right to left. The activity number, description, duration, and estimated earned value shall be shown on the diagram.

##### 3.7.5.2 Project Milestone Dates

Dates shall be shown on the diagram for start of project, any contract

required interim completion dates, and contract completion dates.

#### 3.7.5.3 Critical Path

The critical path shall be clearly shown.

#### 3.7.5.4 Banding

Activities shall be grouped to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

#### 3.7.5.5 S-Curves

Earnings curves showing projected early and late earnings and earnings to date.

### 3.8 PERIODIC PROGRESS MEETINGS

Progress meetings to discuss the project schedule shall include a monthly onsite meeting or other regular more frequent intervals mutually agreed to at the preconstruction conference. During this meeting the Contractor shall describe, on an activity by activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

#### 3.8.1 Meeting Attendance

The Contractor's Project Manager and Scheduler shall attend the regular progress meeting.

#### 3.8.2 Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

#### 3.8.3 Progress Meeting Contents

Update information, included below, shall be subject to the approval of the Contracting Officer. As a minimum, the Contractor shall address the following items on an activity by activity basis during each progress meeting.

##### 3.8.3.1 Start and Finish Dates

The Actual Start and Actual Finish dates for each activity currently in-progress or completed .

##### 3.8.3.2 Time Completion

The estimated Remaining Duration for each activity in-progress. Time-based progress calculations shall be based on Remaining Duration for each activity.

##### 3.8.3.3 Cost Completion

The earnings for each activity started. Payment will be based on earnings

for each in-progress or completed activity. Payment for individual activities will not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

#### 3.8.3.4 Logic Changes

All logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

#### 3.8.3.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and unusual weather. 2) delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary. 3) Changes required to correct a schedule which does not represent the actual or planned prosecution and progress of the work.

### 3.9 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests an extension of the contract completion date, or any interim milestone date, the Contractor shall furnish the following for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract: justification, project schedule data, and supporting evidence as the Contracting Officer may deem necessary. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

#### 3.9.1 Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request.

The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

#### 3.9.2 Submission Requirements

The Contractor shall submit a justification for each request for a change in the contract completion date of under 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

- a. A list of affected activities, with their associated project schedule activity number.
- b. A brief explanation of the causes of the change.
- c. An analysis of the overall impact of the changes proposed.

- d. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

### 3.9.3 Additional Submission Requirements

For any requested time extension of over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

### 3.10 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor with suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

### 3.11 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

-- End of Section --

SECTION 01330

SUBMITTAL PROCEDURES  
07/00

PART 1 GENERAL

1.1 SUBMITTAL IDENTIFICATION

Submittals required are identified by SD numbers as follows:

SD-01 Preconstruction Submittals

SD-02 Shop Drawings

SD-03 Product Data

SD-04 Samples

SD-05 Design Data

SD-06 Test Reports

SD-07 Certificates

SD-08 Manufacturer's Instructions

SD-09 Manufacturer's Field Reports

SD-10 Operation and Maintenance Data

SD-11 Closeout Submittals

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of

construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no re-submittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

#### 1.4 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Contracting Officer.

#### 1.5 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

### PART 2 PRODUCTS (NOT APPLICABLE)

### PART 3 EXECUTION

#### 3.1 GENERAL

The Contractor shall make submittals as required by the specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) System Manager and each item shall be stamped, signed, and dated by the CQC System Manager indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

#### 3.2 SUBMITTAL REGISTER (ENG FORM 4288)

At the end of this section is one set of ENG Form 4288 listing items of equipment and materials for which submittals are required by the specifications; this list may not be all inclusive and additional submittals may be required. The Contractor shall maintain the submittal

register in accordance with Section 01312 RESIDENT MANAGEMENT SYSTEM (RMS).

### 3.3 SUBMITTAL REGISTER FILE

The Contractor will also be given the submittal register files, containing the computerized ENG Form 4288 and instructions on the use of the files. These submittal register files will be furnished on a separate diskette.

### 3.4 SUBMITTAL REGISTER UPDATING

Contractor shall complete the remaining columns and submit the forms (hard copy plus associated electronic file) to the Contracting Officer for approval with the initial project schedule. The Contractor shall keep the submittal register up-to-date and shall submit it to the Government together with the monthly payment request. The approved submittal register will become the scheduling document and will be used to control submittals throughout the life of the contract. The submittal register and the progress schedules shall be coordinated.

### 3.5 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 30 calendar days exclusive of mailing time) shall be allowed and shown on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals. Contractor shall submit all Government-approved submittals within 63 calendar days after notice to proceed.

### 3.6 TRANSMITTAL FORM (ENG FORM 4025)

The transmittal form (ENG Form 4025), produced by the Resident Management System, shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care shall be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

### 3.7 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

#### 3.7.1 Procedures

Procedures shall be incorporated into the Quality Control Plan required in Section 01451.

#### 3.7.2 Procedures for Submittal of Samples

All samples of materials submitted as required by these specifications shall be properly identified and labeled for ready identification, and upon being certified, stored at the site of the work, for job site use, until all work has been completed and accepted by the CO.

### 3.7.3 Contractor Certification

Certification by the Contractor shall be accomplished by using Action Codes A or B of ENG Form 4025-R. The Contractor shall sign and date the certification in Section I. Contractor certified drawings will be subject to quality assurance review by the Government at any time during the duration of the contract. No adjustment for time or money will be allowed for corrections required as a result of non-compliance with the contract documents.

### 3.7.4 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

### 3.8 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

### 3.9 GOVERNMENT APPROVED SUBMITTALS (GA)

The contractor shall provide six copies of Government Approved submittals. Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. Four copies of the submittal will be retained by the Contracting Officer and two copies of the submittal will be returned to the Contractor. Any Government approved submittals designated to go to the A/E shall be directly mailed overnight to the A/E with one copy to the Resident Office.

### 3.10 INFORMATION ONLY SUBMITTALS (FIO)

Normally submittals for information only will not be returned. The contractor shall provide four copies of FIO submittals. Approval of the Contracting Officer is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

### 3.11 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

<p>CONTRACTOR</p> <p>(Firm Name)</p> <p>_____ Approved</p> <p>_____ Approved with corrections as noted on submittal data and/or attached sheets(s).</p> <p>SIGNATURE: _____</p> <p>TITLE: _____</p> <p>DATE: _____</p>
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-- End of Section --

## SECTION 01341

## COLOR/FINISH SAMPLE BOARDS

05/99

## PART 1 GENERAL

## 1.1 SUBMITTALS

- a. Four (4) complete sets of coordinated color/finish sample boards shall be submitted to the Contracting Officer for approval within 63 calendar days after Notice to Proceed (NTP). Upon receipt of the submitted samples, a 14-day review period by the Government can be anticipated.
- b. Exterior and interior color/finish boards shall have attached samples of all interior appearance related construction items the Contractor proposes to furnish, including, but not limited to such items as interior paints; wood finishes; ceramic tile; floor coverings; wall coverings; ceiling tiles; plastic laminates; solid surface materials; signage, etc. Exterior color/finish boards shall have attached samples of all exterior appearance related construction items the Contractor proposes to furnish, including but not limited to such items as brick; mortar; paints; window and door frames; roof; soffits; gutters and downspouts; pre-cast units, etc. Each sample shall indicate color, texture, and finish and shall be identified as to type of material and area of installation. Samples shall be arranged on the board relative to the spaces they represent (e.g. locker room, gym, offices). Technical submittals on finish materials and color boards shall be submitted simultaneously so that compliance with specification requirements is demonstrated at the time of color approval. Identification of each sample shall include the transmittal number under which certification of the material represented has been submitted in accordance with the requirements of Section, SUBMITTAL PROCEDURES. Submittals shall be complete; partial submittals will not be acceptable. The sample board backing material shall be of sufficient strength to maintain its original configuration after samples have been attached to it. The Contractor shall obtain approval of the total construction color board before start of any finish work involving any item included on the color board.
- c. After receipt of final approval from the Government, the Contractor shall prepare and submit to the Contracting Officer two sets of approved and corrected color/finish sample boards. Construction color boards must match those approved during design.

## 1.2 FORMAT

- a. Binders: Provide submittals in 8-1/2 inch by 11 inch format. Use sturdy three-ring binders of appropriate diameter.
- b. Card Stock Sheets: Sheets containing samples shall be heavy, medium gray illustration board (not white or colored) capable of supporting a four inch by eight inch quarry tile, without distorting binder release or causing sheet tear-out due to hole failure.

- c. Mounting: Loose and lost samples are a major concern. All samples must stay mounted for many months of handling. Adhesives must be appropriate for the sample. For instance, white glue is appropriate for paper or cloth and construction adhesive is good for masonry.
- d. Content: A typical color board consists of all samples, a finish schedule, floor plan, and interior elevations with each clearly indicating the location of each finish/color. Items other than material sample boards may be folded to 8-1/2 inch by 11 inch (i.e., floor plans, finish schedules etc.).
- e. Identification: Identify each sample by use, location, and manufacturer's name. Group according to the location where each used.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

## SECTION 01356A

STORM WATER POLLUTION PREVENTION MEASURES  
08/96

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4439	(1997) Standard Terminology for Geosynthetics
ASTM D 4491	(1996) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996)) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(1995) Identification, Storage, and Handling of Geosynthetic Rolls

## 1.2 GENERAL

The Contractor shall implement the storm water pollution prevention measures specified in this section. All erosion and sediment control practices and devices shall comply with the requirements of the Virginia Erosion and Sediment Control Manual.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-07 Certificates

## Mill Certificate or Affidavit

Certificate attesting that the Contractor has met all specified requirements.

## 1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

#### 1.4.1 Stabilization Practices

The stabilization practices to be implemented shall include temporary seeding, geotextiles, protection of trees, etc. On his daily CQC Report, the Contractor shall record the dates when the major grading activities occur, (e.g., clearing and grubbing, excavation, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, stabilization practices shall be initiated as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have permanently ceased.

##### 1.4.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity permanently ceases is precluded by unsuitable conditions caused by the weather, stabilization practices shall be initiated as soon as practicable after conditions become suitable.

##### 1.4.1.2 No Activity for Less Than 21 Days

Where construction activity will resume on a portion of the site within 21 days from when activities ceased (e.g., the total time period that construction activity is temporarily ceased is less than 21 days), then stabilization practices do not have to be initiated on that portion of the site by the fourteenth day after construction activity temporarily ceased.

#### 1.4.2 Structural Practices

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices. Location and details of installation and construction are shown on the drawings.

##### 1.4.2.1 Silt Fences

The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fences shall be installed in the locations indicated on the drawings. Final removal of silt fence barriers shall be upon approval by the Contracting Officer.

##### 1.4.2.2 Construction Entrance

The Contractor shall provide and maintain a Construction Entrance at the location shown on the drawings.

##### 1.4.2.3 Tree Protection

The Contractor shall provide tree protection for all trees and shrubbery to

remain.

#### 1.4.2.4 Inlet Protection

The Contractor shall provide Inlet Protection for all catch basins and curb inlets shown on the drawings. Newly constructed basins and inlets shall have protection installed as soon as they are constructed.

#### 1.4.2.5 Diversion Dikes

Diversion dikes shall have a maximum channel slope of 2 percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic. Diversion dikes shall be located as shown on the drawings.

### PART 2 PRODUCTS

#### 2.1 COMPONENTS FOR SILT FENCES

##### 2.1.1 Filter Fabric

The geotextile shall comply with the requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

#### FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (%)		30 % max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

##### 2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

### 2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

### 2.1.4 Identification Storage and Handling

Filter fabric shall be identified, stored and handled in accordance with ASTM D 4873.

## 2.2 COMPONENTS FOR CONSTRUCTION ENTRANCES

The construction entrances shall be constructed as shown on the drawings and in accordance with the requirements of the Virginia Erosion and Sediment Control Manual.

## 2.3 COMPONENTS FOR TREE PROTECTION

Tree protection shall be constructed with either wooden or metal stakes located at the drip lines. A bright orange mesh fabric, minimum 2 feet in height shall be affixed to the stakes, completely encircling the tree as shown on the drawings.

## 2.4 COMPONENTS FOR INLET PROTECTION

Inlet protection shall be constructed with filter fabric and wooden or metal stakes as shown on the drawings.

# PART 3 EXECUTION

## 3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Contracting Officer.

## 3.2 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.

### 3.2.1 Silt Fence Maintenance

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade.

### 3.2.2 Diversion Dike Maintenance

Diversion dikes shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged diversion dikes and necessary repairs shall be accomplished promptly. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 02935 TURF.

## 3.3 INSPECTIONS

### 3.3.1 General

The Contractor shall inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, such inspection shall be conducted at least once every month.

### 3.3.2 Inspections Details

Disturbed areas and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

### 3.3.3 Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

-- End of Section --

## SECTION 01451

CONTRACTOR QUALITY CONTROL  
07/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(1995b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

## 1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

## 3.1 GENERAL REQUIREMENTS

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence.

## 3.2 QUALITY CONTROL PLAN

The Contractor shall furnish for review by the Government, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. The Government will consider an interim plan for the first 60 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular features of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin

until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.

### 3.2.1 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following, in this order, to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

- a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to an authorized official of the firm.
- b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.
- c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Government.
- d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.
- e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be approved by the Contracting Officer.)
- f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
- g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.
- h. Reporting procedures, including proposed reporting formats.
- i. A list of the definable features of work. A definable feature of work is a task that is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable features under a particular

section. This list will be agreed upon during the coordination meeting.

The QC Plan items above shall include RMS QC requirements.

### 3.2.2 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

### 3.2.3 Notification of Changes

After acceptance of the CQC Plan, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

## 3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. The CQC Plan shall be submitted for review a minimum of 14 calendar days prior to the Coordination Meeting.

During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

## 3.4 QUALITY CONTROL ORGANIZATION

### 3.4.1 Personnel Requirements

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a CQC organization that shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to interview and acceptance by the Contracting Officer or his designated representative.

### 3.4.2 CQC System Manager

The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager will be held responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with quality requirements specified in the contract. The

CQC System Manager shall be:

a. A graduate engineer, graduate architect, or a graduate of construction management, with a minimum of 5 years construction experience on construction similar to this contract.

This CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. The CQC System Manager shall be assigned no other duties. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as for the designated CQC System Manager.

### 3.4.3 CQC Personnel

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide as part of the CQC organization specialized personnel to assist the CQC System Manager for the following areas: electrical, mechanical, and structural. These individuals shall be directly employed by the prime Contractor and may not be employed by a supplier or sub-contractor on this project; be responsible to the CQC System Manager; be physically present at the construction site during work on their areas of responsibility; have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals shall have no other duties other than quality control duties but must be allowed sufficient time to perform their assigned quality control duties as described in the Quality Control Plan. The Structural Engineer shall be an assistant to the CQC Manager.

#### Experience Matrix

Area	Qualifications
a. Mechanical	Graduate Mechanical Engineer with 2 yrs experience or technician with 5 yrs related experience
b. Electrical	Graduate Electrical Engineer with 2 yrs related experience or technician with 5 yrs related experience
c. Telecommunications	A registered communications distribution designer (RCDD) and a Building Industry Consulting Services International (BICSI) Registered Cabling Installation Technician with five years experience in the installation of the specified copper and fiber optic cable and components and distribution in accordance with EIT/TIA standards, or

## Experience Matrix

Area	Qualifications
d. Structural	<p>A registered professional engineer with a minimum of five years experience in the design of the specified copper and fiber optic cable and components and distribution in accordance with EIT/TIA standards.</p> <p>Graduate Structural Engineer with 2 yrs experience or technician with 5 yrs related experience</p>

## 3.4.4 Additional Requirement

In addition to the above experience and education requirements the CQC System Manager shall have completed the course entitled "Construction Quality Management For Contractors" no later than 60 days after the Contractor's receipt of the Notice To Proceed. This course is offered periodically by the Corps of Engineers. Specific times and locations are available from the Contracting Officer.

## 3.4.5 Organizational Changes

The Contractor shall maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

## 3.5 SUBMITTALS AND DELIVERABLES

Submittals, if needed, shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals and deliverables are in compliance with the contract requirements.

## 3.6 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control shall be conducted by the CQC System Manager for each definable feature of work as follows:

## 3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

- a. A review of the paragraphs of applicable specifications, reference

codes, and standards. A copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field shall be made available by the Contractor at the preparatory inspection. These copies shall be maintained in the field and available for use by Government personnel until final acceptance of the work.

- b. A review of the contract drawings.
- c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.
- d. Review of provisions that have been made to provide required control inspection and testing.
- e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.
- f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.
- g. A review of the appropriate activity hazard analysis to assure safety requirements are met.
- h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.
- i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.
- j. Discussion of the initial control phase.
- k. The Government shall be notified at least 48 hours, excluding non-workdays, in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The time and date of the preparatory phase meeting shall be logged in RMS QC. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

### 3.6.2 Initial Phase

This phase shall be accomplished at the beginning of each definable feature of work. The following shall be accomplished:

- a. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.
- b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

- c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
- d. Resolve all differences.
- e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
- f. The Government shall be notified at least 24 hours, excluding non-workdays, in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
- g. The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

### 3.6.3 Follow-up Phase

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon nor conceal non-conforming work.

### 3.6.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if: the quality of on-going work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity; or if other problems develop.

## 3.7 TESTS

### 3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site. The Contractor shall perform the following activities and record and provide the following data:

- a. Verify that testing procedures comply with contract requirements.
- b. Verify that facilities and testing equipment are available and comply with testing standards.

- c. Check test instrument calibration data against certified standards.
- d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
- e. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given or logged into RMS. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

### 3.7.2 Testing Laboratories

#### 3.7.2.1 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

#### 3.7.2.2 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed a charge to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

### 3.7.3 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

## 3.8 COMPLETION INSPECTION

### 3.8.1 Punch-Out Inspection

Near the end of the work, or any increment of the work established by a time stated in the Special Clause, "Commencement, Prosecution, and Completion of Work", or by the specifications, the CQC Manager shall conduct an inspection of the work. A punch list of items that do not conform to the approved drawings and specifications shall be prepared and included in the CQC documentation, as required by paragraph DOCUMENTATION. The list of deficiencies shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that

the facility is ready for the Government Pre-Final inspection.

### 3.8.2 Pre-Final Inspection

The Government will perform the pre-final inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government, so that a Final inspection with the customer can be scheduled. Any items noted on the Pre-Final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate completion dates.

### 3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall be in attendance at the final acceptance inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer, user groups, and major commands may also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notice shall be given to the Contracting Officer at least 14 days prior to the final acceptance inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

## 3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

- a. Contractor/subcontractor and their area of responsibility.
- b. Operating plant/equipment with hours worked, idle, or down for repair.
- c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
- d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase shall be identified (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action.
- e. Quantity of materials received at the site with statement as to

acceptability, storage, and reference to specifications/drawings requirements.

- f. Offsite surveillance activities, including actions taken.
- g. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- h. Instructions given/received and conflicts in plans and/or specifications.
- i. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government daily within 24 hours after the date covered by the report. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

### 3.10 SAMPLE FORMS

Sample forms enclosed at the end of this section.

- a. Attachment No. 1 - Guide for Listing Definable Feature of Construction Work
- b. Attachment No. 2 - Preparatory Phase Checklist
- c. Attachment No. 3 - Initial Phase Checklist
- d. Attachment No. 4 - Daily Construction Quality Control Report
- e. Attachment No. 5 - Test Report
- g. Attachment No. 6 - Deficiency Tracking Log

### 3.11 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

SECTION 01451 ATTACHMENT NO.1  
GUIDE FOR LISTING DEFINABLE FEATURES OF CONSTRUCTION WORK

\*\*\*\*\* Contractor shall modify this guide to accommodate the project \*\*\*\*\*

DIVISION 1 - GENERAL REQUIREMENTS

- (a) Special Project procedures to include coordination of work, Project meetings, Submittals and Quality Control
- (b) Administrative Requirements
- (c) Environmental Protection
- (d) Historic Preservation
- (e) Job Conditions

DIVISION 2 - SITE WORK

- (a) Demolition
- (b) Removal and Disposal of Asbestos Materials
- (c) Excavation, Trenching and Backfilling for Utilities Systems to include sewer gravity drainage and water lines
- (d) Clearing and Grubbing, Backfilling for Buildings
- (e) Grading
- (f) Fence, Chain-Link
- (g) Concrete for sidewalks and Curbs
- (h) Drilled Pile Foundation
- (i) Bituminous Paving
- (j) Underground Sprinkler Systems

DIVISION 3 - CONCRETE

- (a) Concrete Materials, Concrete Procedures, Concrete Formwork, Forms, Form Ties and Accessories, Concrete Reinforcement, Concrete Accessories to Include Cast-in-Place Concrete, Specially Placed Concrete, Concrete Finishing, Concrete Curing and Grouting
- (b) Concrete Restoration and Cleaning
- (c) Precast Concrete
- (d) Electrical and Mechanical Inserts
- (e) Testing
- (f) Approval of Samples

DIVISION 4 - MASONRY

- (a) Masonry Procedures, Mortar, Mortar Accessories, Unit Masonry, Cavity Wall Construction to Include Bringing Inner and Outer Wythes Up Simultaneously, Reinforcement, Wall Ties, Flashing, Masonry Restoration and Cleaning
- (b) Acceptance of Sample Panel for Cavity Wall Construction
- (c) Composite Wall Construction
- (d) Acceptance of Sample Panel for Composite Wall Construction
- (e) CMU Partition Wall Construction to Include Prepared Openings for Ducts, Fire Dampers, Door Frames, Lintels and Bond Beams
- (f) Acceptance of CMU Partition Wall Sample Panel
- (g) Insulation and Waterproofing
- (h) Testing

## ATTACHMENT NO.1 (continued)

## DIVISION 5 - METALS

- (a) Structural Steel Framing To Include Metal Materials and Methods, Metal Fastening, Metal Joints, Welding, Expansion Control and Miscellaneous Metals
- (b) Steel Roof Decking
- (c) High Strength Bolts

## DIVISION 6 - WOODS AND PLASTICS

- (a) Rough Carpentry To Include Framing, Prefabricated Structural Wood, Fasteners and Supports, Roof Sheeting, Siding and Sub-Flooring, Insulation and Flashing (b) Finish Carpentry To Include Wood Treatment, Finish Flooring, Cabinets and Closets

## DIVISION 7 - THERMAL AND MOISTURE PROTECTION

- (a) Dampproofing and Waterproofing
- (b) Fireproofing
- (c) Insulation, Flashing and Sheet Metal, Roof Accessories, Sealants, Shingles, Roof Tiles and Membrane Roofing (Built-Up and EPDM)

## DIVISION 8 - DOORS AND WINDOWS

- (a) Metal Doors and Frames, Wood and Plastic Doors, Special Doors, Door Opening Assemblies, Metal Windows, Wood and Plastic Windows, Special Windows, Glazing and Miscellaneous Hardware, Caulking

## DIVISION 9 - FINISHES

- (a) Ceramic Tile
- (b) Gypsum Wallboard To Include Special Framing, Shaft Wall Framing System, Ceiling and Wall Opening
- (c) Acoustical Treatment to include Metal Suspension System for Acoustical Tile and Lay-In-Panel Ceiling
- (d) Wall Covering
- (e) Carpeting
- (f) Resilient Flooring
- (g) Painting
- (h) Furring (Metal)
- (i) Plastering

## DIVISION 10 - SPECIALTIES

- (a) Metal Toilet Partitions
- (b) Raised Floor System
- (c) Movable Partitions
- (d) Wardrobe
- (e) Fire Extinguisher Cabinets
- (f) Toilet Accessories

## ATTACHMENT NO.1 (continued)

## DIVISION 11 - EQUIPMENT

- (a) Fueling System for Motor Vehicles
- (b) Adjustable Loading Ramps
- (c) Incinerator, Packaged Controlled Air
- (d) Incinerator, Medical Waste, General Purpose, Field Erected
- (e) Food Service Equipment
- (f) Government Furnished Equipment

## DIVISION 12 - FURNISHINGS

- (a) Theater Chairs
- (b) Blinds
- (c) Drapes
- (d) Lockers
- (e) Training Equipment
- (f) Furniture and Accessories
- (g) Rugs and Mats
- (h) Fabrics

## DIVISION 13 - SPECIAL CONSTRUCTION

- (a) RF Shielding
- (b) Sky Lights
- (c) Swimming Pool
- (d) Energy Monitoring and Control System (EMCS)
- (e) Pre-Engineered Structures
- (f) Liquid and Gas Storage Tanks
- (g) Vaults

## DIVISION 14 - CONVEYING SYSTEMS

- (a) Shaft Construction To Include Guides and Guide Rails
- (b) Car Assembly
- (c) Machine Room Layout
- (d) Entrances
- (e) Operating and Signal Devices
- (f) Fire/Emergency Power Operations
- (g) Lighting, Power and Wiring
- (h) Elevator Power Unit
- (i) Acceptance Testing To Include Communications, Safety, Weights,  
Emergency and Fire Operations, Dispatch System

## DIVISION 15 - MECHANICAL

- (a) Insulation to Include:
  - (1) Pipes
  - (2) Ducts
  - (3) Equipment
  - (4) High Density Inserts, Insulation Protective Shields, Clips or U Bolt Supports for Multiple Pipe Hanger Supports
  - (5) Perimeter Insulation

## ATTACHMENT NO. 1 (continued)

- (b) Plumbing Systems
  - (1) Waste/Vent Piping To Include: Underground Soil Piping, Above Ground Soil Piping
  - (2) Interior Piping Rough-In To Include: Galvanized Black Iron and Copper Including Drains, Fittings, Valves and Piping Supports
  - (3) Plumbing Fixtures To Include Flush Valves, Faucets and Accessories
  - (4) Cleaning, Balancing and Operational Testing
- (c) Heating systems
  - (1) Equipment and System Accessories
  - (2) Hot Water/Steam Piping Supports
  - (3) Fuel Oil/Gas Piping and Supports
  - (4) System Testing and Balancing
- (d) Air Distribution Systems
  - (1) Equipment and Accessories
  - (2) Duct Work To Include Galvanized, Aluminum, Flexible and Fiberglass, Supports, Dampers, Louvers, Diffusers, Duct Line Supports and Fire-Dampers
- (e) Refrigeration Systems
  - (1) Equipment and Accessories
  - (2) Chilled Water/Condenser Water Piping and Supports
  - (3) Refrigerant Piping and Supports
  - (4) System Testing
- (f) Automatic Temperature Control Systems
  - (1) Equipment and Materials
  - (2) Installation of Materials and Equipment
  - (3) System Testing
- (g) Underground Heat Distribution Systems
  - (1) Manholes
  - (2) Piping and Supports
  - (3) Cathodic Protection
- (h) Sprinkler Systems
  - (1) Equipment
  - (2) Piping and Supports
  - (3) Accessories
- (i) Water Treatment Systems
- (j) Welding - Piping Systems

## DIVISION 16 - ELECTRICAL

- (a) Exterior Electrical Distribution, Aerial
  - (1) Pole Setting
  - (2) Placement of Crossarms, Pins, Insulators, Pole Line Hardware and Conductors
  - (3) Placement of Fuse Cutouts, Surge Arresters, Reclosers, Potheads, Pole Mounted Transformers to Include Grounding Conductors, Testing and Cable Terminations
- (b) Exterior Electrical Distribution, Underground
  - (1) Duct Line Excavation, Placement of Ducts and Misc. Materials
  - (2) Placement of In Ground Junction or Pull Boxes and Manholes
  - (3) Placement of Duct Bank Concrete Encasement
  - (4) Transformer Pad Placement
  - (5) Mounting of Pad Mounted Transformers

## ATTACHMENT NO.1 (continued)

- (6) Cable Placement to Include Splicing, Fire-Proofing and Cable Terminations
- (7) Grounding Conductors and Testing
- (c) Electrical Distribution, Interior
  - (1) Wiring Methods to Include Conduit Rough-in, Raceway Boxes, Outlet Boxes, Panelboard Cabinets, Placement of Conductors and Conduit Placement Below the Slab for Slab-On-Grade Construction
  - (2) Wiring Devices, Panelboards, Switch-Boards and Lighting Fixtures
  - (3) Motors and Transformers
  - (4) Testing
- (d) Fire Detection and Alarm System
  - (1) Wiring Methods to Include Conduit, Ground Rods, Detectors, Control Panels, Power Supply, Door Holders, Audible Fire Alarm and Annunciator Panel
  - (2) Testing

---End of Attachment No.1---

SECTION 01451 ATTACHMENT NO.2  
PREPARATORY PHASE CHECKLIST

CONTRACTOR'S NAME (Address)

Contract No.: \_\_\_\_\_ Date Preparatory Held: \_\_\_\_\_

Title: \_\_\_\_\_ Spec Section: \_\_\_\_\_

\_\_\_\_\_ Drawing No(s): \_\_\_\_\_

Definable Feature of Work: \_\_\_\_\_

A. PERSONNEL PRESENT:

Name	Position	Company
1. _____	_____	_____
2. _____	_____	_____
3. _____	_____	_____
4. _____	_____	_____
5. _____	_____	_____
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____

(List additional personnel on reverse side)

B. DRAWINGS AND SPECS:

I. Has each spec paragraph, contract drawing, and shop drawing been studied? YES \_\_\_\_\_ NO \_\_\_\_\_

II. Do all parties have up-to-date drawings and specifications? YES \_\_\_\_\_ NO \_\_\_\_\_

C. SHOP DRAWINGS INVOLVED:

Transmittal/Item	Code	Contractor or Gov't Approval
1. _____	_____	_____
2. _____	_____	_____

- 3. \_\_\_\_\_  
\_\_\_\_\_
- 4. \_\_\_\_\_  
\_\_\_\_\_

ATTACHMENT NO.2 (continued)

D. MATERIALS:

I. Are all materials on hand? YES \_\_\_\_\_ NO \_\_\_\_\_

II. Have all materials been checked for contract compliance against approved shop drawings? YES \_\_\_\_\_ NO \_\_\_\_\_

III. Items not on hand or not in accordance with transmittals (if not on hand, check during initial phase):

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_

E. TESTS required in accordance with contract requirements:

Test/Paragraph	Frequency
----------------	-----------

- |                   |  |
|-------------------|--|
| 1. _____<br>_____ |  |
| 2. _____<br>_____ |  |
| 3. _____<br>_____ |  |
| 4. _____<br>_____ |  |
| 5. _____<br>_____ |  |
| 6. _____<br>_____ |  |

F. ACCIDENT PREVENTION: Has Hazard Analysis been completed?

YES \_\_\_\_\_ NO \_\_\_\_\_

If yes, attach a copy, if no, explain:

---



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ATTACHMENT NO.2 (continued)

G. EQUIPMENT Requiring Operational Check:

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_

H. WORKMANSHIP: Have procedures for accomplishing work been reviewed with appropriate people? YES \_\_\_\_\_ NO \_\_\_\_\_

I. PREVIOUS WORK: Has all preliminary work been accomplished in accordance with contract requirements and is this feature of work ready to start? YES \_\_\_\_\_ NO \_\_\_\_\_

Explain any problems: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

J. HI-LIGHTING SPECIFIC ITEMS: Hi-light specific items noted during the Preparatory Phase inspection. ie, (Med. Voltage cable shall be hi-pot tested).

K. OTHER COMMENTS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_  
Quality Control Representative  
Signature

SECTION 01451 ATTACHMENT NO.3  
INITIAL PHASE CHECKLIST

CONTRACTOR'S NAME (Address)

Contract No.: \_\_\_\_\_ Date Initial Held: \_\_\_\_\_

Title: \_\_\_\_\_ Spec Section: \_\_\_\_\_

Drawing No(s).: \_\_\_\_\_

Definable Feature of Work: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

A. PERSONNEL PRESENT:

Name	Position	Company
1. _____		
2. _____		
3. _____		
4. _____		
5. _____		
6. _____		

B. MATERIALS being used are in strict accordance with the contract plans and specifications? YES \_\_\_\_\_ NO \_\_\_\_\_

If not, explain: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

ATTACHMENT NO.3 (continued)

C. WORKMANSHIP:

I. Procedures and/or work methods witnessed are in strict compliance with the requirement of the contract specifications? YES \_\_\_\_\_ NO \_\_\_\_\_

If not, explain: \_\_\_\_\_

\_\_\_\_\_

II. Workmanship is acceptable? YES \_\_\_\_\_ NO \_\_\_\_\_

State area where improvement is needed: \_\_\_\_\_

\_\_\_\_\_

D. SAFETY violations and corrective action taken: \_\_\_\_\_

\_\_\_\_\_

E. COMMENTS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_  
Quality Control Representative  
Signature

SECTION 01451 ATTACHMENT NO.4  
DAILY CONSTRUCTION QUALITY CONTROL REPORT  
(Sample of Typical Contractor Daily Quality Control Report)

CONTRACTORS NAME (Address)

Date \_\_\_\_\_ Report No. \_\_\_\_\_ Contract No. DAC( )  
65-\_\_-C-\_\_\_\_\_ Project Name and Location of work: \_\_\_\_\_

Weather:[Clear] [P.Cloudy] [Cloudy] [Rain: \_\_ inches]  
[Temp.\_\_\_\_min.\_\_\_\_max.] Other Weather Conditions \_\_\_\_\_

1. Contractor (C) or Sub-contractor (S), and Area of Responsibility:

- a. ( ) \_\_\_\_\_ b.
- ( ) \_\_\_\_\_
- c. ( ) \_\_\_\_\_ d.
- ( ) \_\_\_\_\_
- e. ( ) \_\_\_\_\_

2. Equipment Data. (Indicate items of construction equipment, other than hand tools, at the job site and whether or not used):

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. Work Performed Today (Indicate identity of Contractor and Sub-contractors, location , and description of work:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. Results of Surveillance: (Include satisfactory work completed, or deficiencies with action to be taken):

a. Preparatory

Phase: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

b. Initial

Phase: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

c. Follow-up

Phase: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

DAILY CONSTRUCTION QUALITY CONTROL REPORT (Continued)

5. Tests performed as required by plans and specifications and the results:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

6. Verbal instructions received (List instructions given by Government personnel on construction deficiencies, retesting required, etc. Include the name of Government person, time and place instructions given, and action taken to comply:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

7. Job Safety (Include deficiencies and corrective action taken:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

8. Equipment Data (Indicate items of construction equipment, other than hand tools, at the job site, and whether or not used):\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

9. Material and equipment items that arrived at the job site. Indicate compliance or non-compliance of these items with approved shop drawings, the contract plans and specifications, and the storage of the item is required prior to the time of installation, indicate how this storage was provided and whether or not it is adequate:\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

10. Remarks (Cover any conflicts in the plans and specifications, instructions, or delays):\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

CONTRACTOR'S VERIFICATION: THE ABOVE REPORT IS COMPLETE AND ALL DATA LISTED IS CORRECT. ALL MATERIALS PROVIDED, EQUIPMENT USED, AND WORKMANSHIP FOR THIS REPORTING PERIOD ARE IN COMPLIANCE WITH THE CONTRACT PLANS AND SPECIFICATIONS EXCEPT AS NOTED ABOVE.

SIGNED

\_\_\_\_\_ CONTRACTOR'S QC SYSTEM MANAGER

DAILY CONSTRUCTION QUALITY CONTROL REPORT (RMS QC)

CONTRACTORS QUALITY CONTROL REPORT (QCR)  
DAILY OG OF CONSTRUCTION - MILITARY  
REPORT NUMBER

1 PAGE 1

DATE

29 Feb 00 - Tuesday

PROJECT

Sample Project ND RMS, Langley AFB, Virginia  
CONTRACT NUMBER

DACA65-99-C-XXXX  
CONTRACTOR

WEATHER

No Weather Reported

QC NARRATIVES(S)

Activities in Progress:

Include comments here.

Did anything develop that may lead to a Change Order/Claim?

No

Safety Inspection / Safety Meeting:

Include meetings here.

Safety: Inspections made, Deficiencies noted):

Include safety inspections and safety deficiencies here.

Safety: Correction Action taken:

Corrective Action

Verbal Instructions given by Government:

Include instructions here.

Were there any Delays in Work Progress today?

None.

PREP/INITIAL DATES (Preparatory and initial dates held and advance notice)

No preparatory or initial inspections were held today.

ACTIVITY START/FINISH

No activities were started or finished today.

QC REQUIREMENTS

No QC requirements were completed today.

CONTRACTORS QUALITY CONTROL REPORT (QCR)  
DAILY OG OF CONSTRUCTION - MILITARY  
REPORT NUMBER

1 PAGE 2

DATE

29 Feb 00 - Tuesday

PROJECT

Sample Project ND RMS, Langley AFB, Virginia  
CONTRACT NUMBER

DACA65-99-C-XXXX

QA/QC COMMENTS (Describe QC comments issued, report QA and QC comments corrected)

No QC comments were issued today.

CONTRACTORS ON SITE(Report contractor's first and/or last date on site)

No contractors were reported on site today.

LABOR HOURS

No labor hours were reported today.

EQUIPMENT HOURS

No equipment hours were reported today.

EQUIPMENT CHECKS

No equipment inspections were conducted today.

SAFETY CORRECTIONS (Report corrective actions for safety violations)

No outstanding safety violations.

CONTRACTOR CERTIFICATION: On behalf of the contractor, I certify that this report is complete and correct and all equipment and material used and work performed during this reporting period are in compliance with the contract plans and specifications, to the best of my knowledge, except as noted above. QC REPRESENTATIVE'S SIGNATURE

DATE

SUPERINTENDENT'S  
INITIALS

DATE

SECTION 01451 ATTACHMENT NO.5  
TEST REPORT

CONTRACTOR'S NAME (Address)

STRUCTURE OR BUILDING \_\_\_\_\_  
CONTRACT NO. \_\_\_\_\_

DESCRIPTION OF ITEM, SYSTEM OR PART OF SYSTEM  
TESTED: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

DESCRIPTION OF  
TEST: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TESTS FOR CONTRACTOR:

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

SIGNATURE \_\_\_\_\_

I HEREBY CERTIFY THAT THE ABOVE DESCRIBED ITEM, SYSTEM OR PART OF SYSTEM  
HAS BEEN TESTED AS INDICATED ABOVE AND FOUND TO BE ENTIRELY SATISFACTORY AS  
REQUIRED IN THE CONTRACT SPECIFICATIONS.

SIGNATURE OF CONTRACTOR QUALITY CONTROL INSPECTOR

\_\_\_\_\_

DATE \_\_\_\_\_

REMARKS: \_\_\_\_\_  
\_\_\_\_\_

---

SECTION 01451: ATTACHMENT NO. 6  
DEFICIENCY TRACKING LOG

Construction Deficiency: \_\_\_\_\_

Contract No.

Safety Deficiency: \_\_\_\_\_

Project Title:

Date Reported

Description of Corrective

Reported By  
Deficient Work

Action Taken  
Date Corrected

Verified By

-- End of Section --

SECTION 01500  
TEMPORARY CONSTRUCTION FACILITIES

07/00

## PART 1 GENERAL

## 1.1 GENERAL REQUIREMENTS

## 1.1.1 Site Plan

The Contractor shall prepare a site plan indicating the proposed location and dimensions of any area to be fenced and used by the Contractor, the number of trailers to be used, entrance(s), utilities, and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified. The Contractor shall also indicate any supplemental or other staging area.

## 1.1.2 Identification of Employees

The Contractor shall be responsible for furnishing to each employee and for requiring each employee engaged on the work to display identification as approved and directed by the Contracting Officer. Prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of any employee. When required, the Contractor shall obtain and provide fingerprints of persons employed on the project. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works.

## 1.1.3 Employee Parking

Contractor employees shall park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Contractor employee parking shall not interfere with existing and established parking requirements of the facility.

## 1.2 AVAILABILITY AND USE OF UTILITY SERVICES

## 1.2.1 Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies that currently exist at the project site, as specified in the contract. The Contractor shall carefully conserve utilities furnished without charge.

## 1.2.2 Meters and Temporary Connections

The Contractor, at its expense and in a workmanlike manner satisfactory to the Contracting Officer, shall provide, install, and maintain all necessary temporary connections, distribution lines, meters, and meter bases required to measure the amount of each utility used for the purpose of determining charges. The Contractor shall notify the Contracting Officer, in writing, 5 working days before final electrical connection is desired so that a utilities contract can be established. After inspection and approval of the Contractor's temporary wiring installation, the Contracting Officer will then inform the Facility to make the final service connection. Under no circumstance shall the Contractor make the final electrical connection.

Other utility connections shall be made by the Contractor as directed by the Contracting Officer.

#### 1.2.3 Sanitation

The Contractor shall provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer. Government toilet facilities will not be available to Contractor's personnel.

#### 1.2.4 Telephone

The Contractor shall make arrangements and pay all costs for telephone facilities desired.

### 1.3 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

#### 1.3.1 Bulletin Board

Within fifteen days after receipt of the Notice To Proceed, the Contractor shall provide a weatherproof bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract documents, Wage Rate Information poster, and other information required or approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place, outside of the contractor's temporary office, easily accessible to all employees, as approved by the Contracting Officer.

Legible copies of the aforementioned data shall be displayed until work under this contract is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

#### 1.3.2 Project and Safety Signs

The requirements for the signs, their content, and location shall be provided at a location designated by the Contracting Officer. The signs shall be erected within 15 days after receipt of the Notice to Proceed. The data required by the safety sign shall be corrected daily, with light colored metallic or non-metallic numerals. Upon completion of the project, the signs shall be removed and disposed of by the Contractor.

##### 1.3.2.1 Project Sign

The project sign shall conform to the requirements as indicated on Attachment No. 2, attached hereto.

##### 1.3.2.2 Safety Sign

The safety sign shall conform to the requirements as indicated on Attachment Nos. 1A and 1B, attached hereto. The data required by the sign shall be corrected daily, with light colored metallic or non-metallic numerals. Numerals, including mounting hardware, shall be subject to the approval of the CO.

##### 1.3.2.3 Payment

No separate payment will be made for the sign work covered under this section of the specifications and all costs in connection therewith will be considered as a subsidiary obligation of the Contractor, covered by the contract prices in this contract.

#### 1.4 PROTECTION AND MAINTENANCE OF TRAFFIC

During construction the Contractor shall provide access and temporary relocated roads as necessary to maintain traffic. The Contractor shall maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flag men, erection of barricades, placing of lights around and in front of equipment and the work, and the erection and maintenance of adequate warning, danger, and direction signs, shall be as required by the State and local authorities having jurisdiction. The traveling public shall be protected from damage to person and property. The Contractor's traffic on roads selected for hauling material to and from the site shall interfere as little as possible with public traffic. The Contractor shall investigate the adequacy of existing roads and the allowable load limit on these roads. The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

##### 1.4.1 Haul Roads

The Contractor shall, at its own expense, construct access and haul roads necessary for proper prosecution of the work under this contract. Haul roads shall be constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided. The Contractor shall provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control shall be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and hauling roads shall be subject to approval by the Contracting Officer. Lighting shall be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations. Upon completion of the work, haul roads designated by the Contracting Officer shall be removed.

##### 1.4.2 Barricades

The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night. Barricades and other physical protection shall be in accordance with EM 385-1-1.

#### 1.5 CONTRACTOR'S TEMPORARY FACILITIES

##### 1.5.1 Administrative Field Offices and Storage Areas

The Contracting Officer will designate an area within the construction limits for which the Contractor shall be permitted to place administrative or storage trailers for equipment and limited construction materials other than in trailers. The Contractor shall provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

##### 1.5.1.1 Storage Area(s)

The Contractor shall construct a temporary 6-foot high chain link fence around all trailers and materials. The fence shall include plastic strip inserts, colored brown, such that visibility through the fence is obstructed. Fence posts may be driven in lieu of concrete bases where soil conditions permit. No trailers, materials, or equipment shall be placed or stored outside the fenced area unless such trailers, materials or equipment are assigned a separate and distinct storage area by the CO away from the vicinity of the construction site but within the boundaries of the Post. At no time shall trailers, equipment or materials be open to public view with the exception of those items which are in support of ongoing work on any given day. Materials shall not be stockpiled outside the fence in preparation for the next day's work. At the end of each work day, mobile equipment such as tractors, wheeled lifting equipment, cranes, trucks and like equipment shall be parked within the fenced area.

#### 1.5.1.2 Appearance of Trailers

Trailers utilized by the Contractor, whether for the purpose of administrative use or materials storage, shall present a clean and neat exterior appearance and be in a state of good repair. Trailers which, in the opinion of the CO, are not in good repair shall not be allowed on the Post.

#### 1.5.1.3 Equipment

Any item of construction equipment, with the exception of hand tools, which becomes inoperable shall be repaired within five (5) working days or removed from the construction site.

#### 1.5.1.4 Maintenance of Storage Area(s)

It shall be the responsibility of the Contractor to keep all fencing in a state of good repair and proper alignment. Should the Contractor elect to traverse grassed or other areas without paving that are not established roadways, with construction equipment or other vehicles, such grassed or other areas shall be covered with a layer of gravel as necessary to prevent rutting and to prevent the tracking of mud onto paved or established roadways. Gradation of the gravel shall be at the discretion of the Contractor. The Contractor shall be responsible for the cutting of grass located within the boundaries of the construction site for the duration of the project. Grass and vegetation along fences, buildings, under trailers and in areas not accessible to mowers shall be edged or trimmed neatly.

### 1.6 SECURITY

#### 1.6.1 Security Provisions

Adequate outside security lighting shall be provided at the Contractor's temporary facilities. The Contractor shall be responsible for the security of its own equipment; in addition, the Contractor shall notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

### 1.7 CLEANUP

Construction debris, waste materials, packaging material and the like shall be removed from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways shall be cleaned away. Materials resulting from

demolition activities which are salvageable shall be stored within the fenced area described above or at the supplemental storage area. Stored material not in trailers, whether new or salvaged, shall be neatly stacked when stored.

#### 1.8 RESTORATION OF STORAGE AREA

Upon completion of the project and after removal of trailers, materials, and equipment from within the fenced area, the fence shall be removed and will become the property of the Contractor. Areas used by the Contractor for the storage of equipment or material, or other use, shall be restored to the original or better condition. Gravel used to traverse grassed areas shall be removed and the area restored to its original condition, including top soil and seeding as necessary.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

-- End of Section --

SECTION 01560  
ENVIRONMENTAL PROTECTION (PROJECT SITE)

03/96

## PART 1 GENERAL

## 1.1 DEFINITIONS

For the purpose of this specification environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare, unfavorably alter ecological balances of importance to human life, and may affect other species and natural resources of importance to man.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are listed in the text by basic designation only.

## CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.94-SUBPART G	Occupational Health and Environmental Control
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Generators of Hazardous Waste
40 CFR 263	Transporters of Hazardous Waste
40 CFR 264	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
49 CFR 178	Shipping Container Specifications

## CORPS OF ENGINEERS (COE)

EP-1165-2-304	Perspective on Flood Plain Regulations for Flood Plain Management (1976)
ER-1165-2-26	Implementation of Executive Order 11988 on Flood Plain Management (March 1984)
EM 385-1-1	Safety and Health Requirements Manual (September 1996)

## VIRGINIA SOIL AND WATER CONSERVATION COMMISSION (VSWCC)

VESCH	Virginia Erosion and Sediment Control Handbook (1992)
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## VIRGINIA ADMINISTRATIVE CODE

9VAC25-31	Virginia Pollutant Discharge Elimination System
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9VAC25-180

(VPDES) General Permit For Storm Water  
Discharges From Construction Sites

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Preconstruction Survey; G

Prior to commencement of work the Contractor shall perform a preconstruction survey of the project site with the Contracting Officer and take photographs showing existing environmental conditions in and adjacent to the site. A brief report of the results of this survey shall be prepared by the contractor and copies furnished to the Contracting Officer. The contractor shall certify that he has read and understands regulations 29 CFR 1910.94-SUBPART G, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 49 CFR 178, EP-1165-2-304, ER-1165-2-26, 9VAC25-31, 9VAC25-180, and VESCH provide proof that he has performed work in accordance with these regulations.

## Environmental Protection Plan; G

The Contractor shall submit for approval within 10 days after Notice to Proceed, and prior to any work on the site, his written Environmental Protection Plan. The Contractor shall meet with the Contracting Officer, to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to the details of environmental protection, including measures for protecting natural resources, required reports, and other measures to be taken. The plan shall demonstrate compliance with 29 CFR 1910.94-SUBPART G, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 49 CFR 178, EM 385-1-1, EP-1165-2-304, ER-1165-2-26, VR 680-14-19, and VESCH.

## Erosion Control Plan; G

The contractor shall, within 10 days after the Notice to Proceed, submit an Erosion Control Plan in accordance with VESCH and as otherwise specified for approval of the Contracting Officer, showing the Contractor's scheme for controlling erosion and disposing of wastes. The Erosion Control Plan shall include as a minimum the following items indicating adequate measures to:

- a. Reduce by the greatest extent practicable the area and duration of exposure of readily erodible soils.
- b. Protect the soils by use of temporary vegetation, or seeding and mulch, or by accelerating the establishment of permanent vegetation. Complete and protect segments of work as rapidly as is consistent with construction schedules.
- c. Retard the rate of runoff from the construction site and control disposal of runoff.

- d. Sprinkle or apply dust suppressors, or otherwise keep dust within tolerable limits on haul roads and at the site.
- e. Borrow areas furnished by the contractor shall be at a location where pollution from the operation can be minimized. Locations should be avoided where pollution would be inevitable.
- f. Provide temporary measures for the control of erosion in the event construction operations are suspended for any appreciable length of time.
- g. Provide protection against discharge of pollutants such as chemicals, fuel, lubricants, or sewage into any stream.
- h. Locate sanitary facilities away from streams, wells, or springs.

#### 1.4 GENERAL REQUIREMENTS

##### 1.4.1 General

The work covered by this section consists of furnishing all labor, materials and equipment and performing all work required for the prevention of environmental pollution during and as the result of construction operations under this contract. In the event the measures set forth in other Technical Provisions of these specifications and this Section conflict, the most stringent standard shall apply. The control of environmental pollution requires consideration of air, water, and land.

##### 1.4.2 Provisions

Provide and maintain, during the life of the contract, environmental protection.

Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project.

##### 1.4.3 Compliance

The contractor shall comply with Federal, state, and local regulations pertaining to the environmental pollution control and abatement, including but not limited to water, air, land, and noise pollution. All applicable provisions of the Corps of Engineers Manual, EM 385-1-1, entitled "Safety and Health Requirements Manual" in effect on the date of solicitation, as well as the specific requirements stated elsewhere in the contract specifications shall be strictly observed and enforced.

#### PART 2 PRODUCTS (NOT APPLICABLE)

#### PART 3 EXECUTION

##### 3.1 NOTIFICATION

The Contracting Officer will notify the contractor in writing of any non-compliance with the foregoing provisions and the action to be taken. The contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the contractor or his authorized representative at the site of the work, shall be deemed

sufficient for the purpose. If the contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the contractor unless it was later determined that the contractor was in compliance.

### 3.2 SUBCONTRACTORS

Compliance with the provisions of this section by subcontractors will be the responsibility of the contractor.

### 3.3 PROTECTION OF WATER RESOURCES

The contractor shall not pollute streams, lakes or reservoirs with fuels, oils, bitumens, calcium chloride, acid construction wastes or other harmful materials. It is the responsibility of the contractor to investigate and comply with all applicable Federal, State, County and Municipal laws concerning pollution of rivers and streams. All work under this contract shall be performed in such a manner that objectionable conditions will not be created in streams through or adjacent to the project areas.

### 3.4 INDUSTRIAL POLLUTION HAZARDS

Hazardous substances as defined in 40 CFR 261 or as defined by applicable state and local regulations, and dust which poses air pollution hazards shall be controlled as approved to comply with all applicable laws which govern the work.

#### 3.4.1 DUST CONTROL

The contractor shall maintain all work areas free from dust which would contribute to air pollution. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

### 3.5 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

During the life of this contract the contractor shall maintain all facilities constructed for pollution control under this contract as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

### 3.6 MAINTENANCE OF PERMITS

The Contractor shall immediately provide to the Contracting Officer two copies of any modification, revocation or reissuance of any applicable permit required to complete the work. The Contractor shall provide two copies of all correspondence with Federal, State or Local Government offices regarding any applicable permit within 5 days. The Contractor shall notify the Contracting Officer in writing at least 5 days prior to any visit to the site by any Federal, State or Local Government office,

other than those scheduled by the Contracting Officer, scheduled to observe compliance with applicable permits provided the Contractor receives at least 5 days notice. Otherwise the Contractor shall immediately provide the Contracting Officer written notice of the date, time, office(s) participating and features to be observed by the most expeditious means available.

-- End of Section --

## SECTION 01670

## RECYCLED / RECOVERED MATERIALS

12/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247 Comprehensive Procurement Guideline for  
Products Containing Recovered Materials

## 1.2 OBJECTIVES

Government procurement policy is to acquire, in a cost effective manner, items containing the highest percentage of recycled and recovered materials practicable consistent with maintaining a satisfactory level of competition without adversely affecting performance requirements or exposing suppliers' employees to undue hazards from the recovered materials. The Environmental Protection Agency (EPA) has designated certain items which must contain a specified percent range of recovered or recycled materials. EPA designated products specified in this contract comply with the stated policy and with the EPA guidelines. The Contractor shall make all reasonable efforts to use recycled and recovered materials in providing the EPA designated products and in otherwise utilizing recycled and recovered materials in the execution of the work.

## 1.3 EPA DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designated by EPA as being products which are or can be made with recovered or recycled materials. These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered materials unless adequate justification (non-availability) for non-use is provided. When a designated item is specified as an option to a non-designated item, the designated item requirements apply only if the designated item is used in the work.

## 1.4 EPA PROPOSED ITEMS INCORPORATED IN THE WORK

Products other than those designated by EPA are still being researched and are being considered for future Comprehensive Procurement Guideline (CPG) designation. It is recommended that these items, when incorporated in the work under this contract, contain the highest practicable percentage of recycled or recovered materials, provided specified requirements are also met.

## 1.5 EPA LISTED ITEMS USED IN CONDUCT OF THE WORK BUT NOT INCORPORATED IN THE WORK

There are many products listed in 40 CFR 247 which have been designated or proposed by EPA to include recycled or recovered materials that may be used by the Contractor in performing the work but will not be incorporated into the work. These products include office products, temporary traffic control products, and pallets. It is recommended that these non-construction products, when used in the conduct of the work, contain the highest practicable percentage of recycled or recovered materials and that these products be recycled when no longer needed.

-- End of Section --

## SECTION 01780A

## CLOSEOUT SUBMITTALS

05/02

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## As-Built Drawings; G

Drawings showing final as-built conditions of the project. The final CADD as-built drawings shall consist of one set of electronic CADD drawing files in the specified format, one set of mylar drawings, 2 sets of blue-line prints of the mylars, and one set of the approved working as-built drawings.

## SD-03 Product Data

## As-Built Record of Equipment and Materials; G

Two copies of the record listing the as-built materials and equipment incorporated into the construction of the project.

## Warranty Management Plan; G

One set of the warranty management plan containing information relevant to the warranty of materials and equipment incorporated into the construction project, including the starting date of warranty of construction. The Contractor shall furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

## Warranty Tags; G

Two record copies of the warranty tags showing the layout and design.

## Final Cleaning; G

Two copies of the listing of completed final clean-up items.

## 1.2 PROJECT RECORD DOCUMENTS

## 1.2.1 As-Built Drawings

This paragraph covers as-built drawings complete, as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files,"

"working as-built drawings" and "final as-built drawings" refer to contract drawings which are revised to be used for final as-built drawings.

#### 1.2.1.1 Government Furnished Materials

One set of electronic CADD files in the specified software and format revised to reflect all bid amendments will be provided by the Government at the preconstruction conference for projects requiring CADD file as-built drawings.

#### 1.2.1.2 Working As-Built and Final As-Built Drawings

The Contractor shall revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. These working as-built marked drawings shall be kept current on a weekly basis and at least one set shall be available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes.

Final as-built drawings shall be prepared after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working as-built marked prints and final as-built drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final as-built drawings as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the as-built drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of updated drawings. The working and final as-built drawings shall show, but shall not be limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, the as-built drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

- f. Changes or modifications which result from the final inspection.
- g. Where contract drawings or specifications present options, only the option selected for construction shall be shown on the final as-built prints.
- h. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, the Contractor shall furnish a contour map of the final borrow pit/spoil area elevations.
- i. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.
- j. Modifications (change order price shall include the Contractor's cost to change working and final as-built drawings to reflect modifications) and compliance with the following procedures.
  - (1) Directions in the modification for posting descriptive changes shall be followed.
  - (2) A Modification Circle shall be placed at the location of each deletion.
  - (3) For new details or sections which are added to a drawing, a Modification Circle shall be placed by the detail or section title.
  - (4) For minor changes, a Modification Circle shall be placed by the area changed on the drawing (each location).
  - (5) For major changes to a drawing, a Modification Circle shall be placed by the title of the affected plan, section, or detail at each location.
  - (6) For changes to schedules or drawings, a Modification Circle shall be placed either by the schedule heading or by the change in the schedule.
  - (7) The Modification Circle size shall be 1/2 inch diameter unless the area where the circle is to be placed is crowded. Smaller size circle shall be used for crowded areas.

#### 1.2.1.3 Drawing Preparation

The as-built drawings shall be modified as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working as-built prints, and adding such additional drawings as may be necessary. These working as-built marked prints shall be neat, legible and accurate. These drawings are part of the permanent records of this project and shall be returned to the Contracting Officer after approval by the Government. Any drawings damaged or lost by the Contractor shall be satisfactorily replaced by the Contractor at no expense to the Government.

#### 1.2.1.4 Computer Aided Design and Drafting (CADD) Drawings

Only personnel proficient in the preparation of CADD drawings shall be employed to modify the contract drawings or prepare additional new drawings. Additions and corrections to the contract drawings shall be equal in quality and detail to that of the originals. Line colors, line

weights, lettering, layering conventions, and symbols shall be the same as the original line colors, line weights, lettering, layering conventions, and symbols. If additional drawings are required, they shall be prepared using the specified electronic file format applying the same graphic standards specified for original drawings. The title block and drawing border to be used for any new final as-built drawings shall be identical to that used on the contract drawings. Additions and corrections to the contract drawings shall be accomplished using CADD files. The Contractor will be furnished "as-designed" drawings in AutoCad Release 14 format compatible with a Windows NT operating system. The electronic files will be supplied on compact disc, read-only memory (CD-ROM). The Contractor shall be responsible for providing all program files and hardware necessary to prepare final as-built drawings. The Contracting Officer will review final as-built drawings for accuracy and the Contractor shall make required corrections, changes, additions, and deletions.

a. CADD colors shall be the "base" colors of red, green, and blue. Color code for changes shall be as follows:

- (1) Deletions (red) - Deleted graphic items (lines) shall be colored red with red lettering in notes and leaders.
- (2) Additions (Green) - Added items shall be drawn in green with green lettering in notes and leaders.
- (3) Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes shall be in blue.

b. The Contract Drawing files shall be renamed in a manner related to the contract number (i.e., 98-C-10.DGN) as instructed in the Pre-Construction conference. Marked-up changes shall be made only to those renamed files. All changes shall be made on the layer/level as the original item. There shall be no deletions of existing lines; existing lines shall be over struck in red. Additions shall be in green with line weights the same as the drawing. Special notes shall be in blue on layer #63.

c. When final revisions have been completed, the cover sheet drawing shall show the wording "RECORD DRAWING AS-BUILT" followed by the name of the Contractor in letters at least 3/16 inch high. All other contract drawings shall be marked either "AS-Built" drawing denoting no revisions on the sheet or "Revised As-Built" denoting one or more revisions. Original contract drawings shall be dated in the revision block.

d. Within 20 days for contracts \$5 million and above after Government approval of all of the working as-built drawings for a phase of work, the Contractor shall prepare the final CADD as-built drawings for that phase of work and submit two sets of blue-lined prints of these drawings for Government review and approval. The Government will promptly return one set of prints annotated with any necessary corrections. Within 10 days for contracts \$5 million and above the Contractor shall revise the CADD files accordingly at no additional cost and submit one set of final prints for the completed phase of work to the Government. Within 20 days for contracts \$5 million and above of substantial completion of all phases of work, the Contractor shall submit the final as-built drawing package for the entire project. The submittal shall consist of one set of electronic files on 3-1/2 inch high density floppy disks (for projects with electronic digital files or sets of files less than or equal to 4 diskettes) compact

disc, read-only memory (CD-ROM), one set of mylars, two sets of blue-line prints and one set of the approved working as-built drawings. They shall be complete in all details and identical in form and function to the contract drawing files supplied by the Government. Any transactions or adjustments necessary to accomplish this is the responsibility of the Contractor. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CADD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final as-built drawing files and marked prints as specified shall be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final as-built drawings shall be accomplished before final payment is made to the Contractor.

#### 1.2.2 As-Built Record of Equipment and Materials

The Contractor shall furnish one copy of preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 2 days after final inspection with Government comments. Two sets of final record of equipment and materials shall be submitted 10 days after final inspection. The designations shall be keyed to the related area depicted on the contract drawings. The record shall list the following data:

##### RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA

Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used
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#### 1.2.3 Final Approved Shop Drawings

The Contractor shall furnish final approved project shop drawings 30 days after transfer of the completed facility.

#### 1.2.4 Construction Contract Specifications

The Contractor shall furnish final as-built construction contract specifications, including modifications thereto, 30 days after transfer of the completed facility.

#### 1.2.5 Real Property Equipment

The Contractor shall furnish a list of installed equipment furnished under this contract. The list shall include all information usually listed on manufacturer's name plate. The "EQUIPMENT-IN-PLACE LIST" shall include, as applicable, the following for each piece of equipment installed: description of item, location (by room number), model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. A draft list shall be furnished at time of transfer. The final list shall be furnished 30 days after transfer of the completed facility.

### 1.3 WARRANTY MANAGEMENT

#### 1.3.1 Warranty Management Plan

The Contractor shall develop a warranty management plan which shall contain information relevant to the clause Warranty of Construction in Section 00700.

At least 30 days before the planned pre-warranty conference, the Contractor shall submit the warranty management plan for Government approval. The warranty management plan shall include all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan shall be in narrative form and contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below shall include due date and whether item has been submitted or was accomplished. Warranty information made available during the construction phase shall be submitted to the Contracting Officer for approval prior to each monthly pay estimate. Approved information shall be assembled in a binder and shall be turned over to the Government upon acceptance of the work. The construction warranty period shall begin on the date of project acceptance and shall continue for the full product warranty period. A joint 4 month and 9 month warranty inspection shall be conducted, measured from time of acceptance, by the Contractor, Contracting Officer and the Customer Representative. Information contained in the warranty management plan shall include, but shall not be limited to, the following:

a. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subcontractors, manufacturers or suppliers involved.

b. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, and for all commissioned systems such as fire protection and alarm systems, sprinkler systems, lightning protection systems, etc.

c. A list for each warranted equipment, item, feature of construction or system indicating:

1. Name of item.
2. Model and serial numbers.
3. Location where installed.
4. Name and phone numbers of manufacturers or suppliers.
5. Names, addresses and telephone numbers of sources of spare parts.
6. Warranties and terms of warranty. This shall include one-year overall warranty of construction. Items which have extended warranties shall be indicated with separate warranty expiration dates.
7. Cross-reference to warranty certificates as applicable.
8. Starting point and duration of warranty period.
9. Summary of maintenance procedures required to continue the warranty in force.
10. Cross-reference to specific pertinent Operation and Maintenance manuals.
11. Organization, names and phone numbers of persons to call for warranty service.
12. Typical response time and repair time expected for various warranted equipment.

d. The Contractor's plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

e. Procedure and status of tagging of all equipment covered by extended warranties.

f. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

#### 1.3.2 Performance Bond

The Contractor's Performance Bond shall remain effective throughout the construction period.

a. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

b. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the Contractor's expense, the Contracting Officer will have the right to recoup expenses from the bonding company.

c. Following oral or written notification of required construction warranty repair work, the Contractor shall respond in a timely manner. Written verification will follow oral instructions. Failure of the Contractor to respond will be cause for the Contracting Officer to proceed against the Contractor.

#### 1.3.3 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer, the Contractor shall meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this section. Communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty shall be established/reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, the Contractor shall furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact will be located within the local service area of the warranted construction, shall be continuously available, and shall be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

#### 1.3.4 Contractor's Response to Construction Warranty Service Requirements

Following oral or written notification by the Contracting Officer, the Contractor shall respond to construction warranty service requirements in accordance with the "Construction Warranty Service Priority List" and the three categories of priorities listed below. The Contractor shall submit a report on any warranty item that has been repaired during the warranty period. The report shall include the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframes

specified, the Government will perform the work and backcharge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-Air Conditioning Systems

- (1) Recreational support.
- (2) Air conditioning leak in part of building, if causing damage.
- (3) Air conditioning system not cooling properly.

Code 1-Doors

- (1) Overhead doors not operational, causing a security, fire, or safety problem.
- (2) Interior, exterior personnel doors or hardware, not functioning properly, causing a security, fire, or safety problem.

Code 3-Doors

- (1) Overhead doors not operational.
- (2) Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical

- (1) Power failure (entire area or any building operational after 1600 hours).
- (2) Security lights
- (3) Smoke detectors

Code 2-Electrical

- (1) Power failure (no power to a room or part of building).
- (2) Receptacle and lights (in a room or part of building).

Code 3-Electrical

Street lights.

Code 1-Gas

- (1) Leaks and breaks.
- (2) No gas to family housing unit or cantonment area.

Code 1-Heat

- (1). Area power failure affecting heat.
- (2). Heater in unit not working.

Code 2-Kitchen Equipment

- (1) Dishwasher not operating properly.
- (2) All other equipment hampering preparation of a meal.

Code 1-Plumbing

- (1) Hot water heater failure.

(2) Leaking water supply pipes.

Code 2-Plumbing

- (1) Flush valves not operating properly.
- (2) Fixture drain, supply line to commode, or any water pipe leaking.
- (3) Commode leaking at base.

Code 3 -Plumbing

Leaky faucets.

Code 3-Interior

- (1) Floors damaged.
- (2) Paint chipping or peeling.
- (3) Casework.

Code 1-Roof Leaks

Temporary repairs will be made where major damage to property is occurring.

Code 2-Roof Leaks

Where major damage to property is not occurring, check for location of leak during rain and complete repairs on a Code 2 basis.

Code 2-Water (Exterior)

No water to facility.

Code 2-Water (Hot)

No hot water in portion of building listed.

Code 3-All other work not listed above.

1.3.5 Warranty Tags

At the time of installation, each warranted item shall be tagged with a durable, oil and water resistant tag approved by the Contracting Officer. Each tag shall be attached with a copper wire and shall be sprayed with a silicone waterproof coating. The date of acceptance and the QC signature shall remain blank until project is accepted for beneficial occupancy. The tag shall show the following information.

- a. Type of product/material\_\_\_\_\_.
- b. Model number\_\_\_\_\_.
- c. Serial number\_\_\_\_\_.
- d. Contract number\_\_\_\_\_.
- e. Warranty period\_\_\_\_\_ from\_\_\_\_\_ to\_\_\_\_\_.
- f. Inspector's signature\_\_\_\_\_.
- g. Construction Contractor\_\_\_\_\_.
- Address\_\_\_\_\_.
- Telephone number\_\_\_\_\_.

h. Warranty contact\_\_\_\_\_.

Address\_\_\_\_\_.

Telephone number\_\_\_\_\_.

i. Warranty response time priority code\_\_\_\_\_.

j. WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.

#### 1.4 MECHANICAL TESTING, ADJUSTING, BALANCING, AND COMMISSIONING

Prior to final inspection and transfer of the completed facility; all reports, statements, certificates, and completed checklists for testing, adjusting, balancing, and commissioning of mechanical systems shall be submitted to and approved by the Contracting Officer as specified in applicable technical specification sections.

#### 1.5 OPERATION AND MAINTENANCE MANUALS

Operation manuals and maintenance manuals shall be submitted as specified. Operation manuals and maintenance manuals provided in a common volume shall be clearly differentiated and shall be separately indexed.

#### 1.6 FINAL CLEANING

The premises shall be left broom clean. Stains, foreign substances, and temporary labels shall be removed from surfaces. Carpet and soft surfaces shall be vacuumed. Equipment and fixtures shall be cleaned to a sanitary condition. Filters of operating equipment shall be cleaned. Debris shall be removed from roofs, drainage systems, gutters, and downspouts. Paved areas shall be swept and landscaped areas shall be raked clean. The site shall have waste, surplus materials, and rubbish removed. The project area shall have temporary structures, barricades, project signs, and construction facilities removed. A list of completed clean-up items shall be submitted on the day of final inspection.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

-- End of Section --

## SECTION 01781

OPERATION AND MAINTENANCE DATA  
12/01

## PART 1 GENERAL

## 1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01330, "Submittal Procedures."

## 1.1.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

## 1.1.2 Package Content

Data package content shall be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." Comply with the data package requirements specified in the individual technical sections, including the content of the packages and addressing each product, component, and system designated for data package submission.

## 1.1.3 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data shall be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, shall be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

## 1.2 TYPES OF INFORMATION REQUIRED IN O&amp;M DATA PACKAGES

## 1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation:

## 1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

## 1.2.1.2 Operator Prestart

Include procedures required to set up and prepare each system for use.

## 1.2.1.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown

operating procedures including the control sequence for each procedure.

#### 1.2.1.4 Normal Operations

Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.

#### 1.2.1.5 Emergency Operations

Include Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of all utility systems including required valve positions, valve locations and zones or portions of systems controlled.

#### 1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gage readings.

#### 1.2.1.7 Environmental Conditions

Include a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item equipment should not be allowed to run.

#### 1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair.

##### 1.2.2.1 Lubrication Data

Include preventative maintenance lubrication data, in addition to instructions for lubrication provided under paragraph titled "Operator Service Requirements":

- a. A table showing recommended lubricants for specific temperature ranges and applications.
- b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.
- c. A Lubrication Schedule showing service interval frequency.

##### 1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

### 1.2.3 Corrective Maintenance (Repair)

Include manufacturer's recommended procedures and instructions for correcting problems and making repairs.

#### 1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

#### 1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

#### 1.2.3.3 Maintenance and Repair Procedures

Include instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards.

#### 1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and a list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

#### 1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

### 1.2.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including requirements by type of craft. Corrective maintenance that requires completion or participation of the equipment manufacturer shall be identified and tabulated separately.

### 1.2.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

#### 1.2.6 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master parts catalog

#### 1.2.6.1 Warranty Information

List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

#### 1.2.6.2 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

#### 1.2.6.3 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

#### 1.2.6.4 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

### 1.3 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

#### 1.3.1 Data Package 1

- a. Safety precautions
- b. Maintenance and repair procedures
- c. Warranty information
- d. Contractor information

- e. Spare parts and supply list

#### 1.3.2 Data Package 2

- a. Safety precautions
- b. Normal operations
- c. Environmental conditions
- d. Lubrication data
- e. Preventive maintenance plan and schedule
- f. Maintenance and repair procedures
- g. Removal and replacement instructions
- h. Spare parts and supply list
- i. Parts identification
- j. Warranty information
- k. Contractor information

#### 1.3.3 Data Package 3

- a. Safety precautions
- b. Normal operations
- c. Emergency operations
- d. Environmental conditions
- e. Lubrication data
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring diagrams and control diagrams
- i. Maintenance and repair procedures
- j. Removal and replacement instructions
- k. Spare parts and supply list
- l. Parts identification
- m. Warranty information
- n. Testing equipment and special tool information
- o. Contractor information

## 1.3.4 Data Package 4

- a. Safety precautions
- b. Operator prestart
- c. Startup, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Emergency operations
- f. Operator service requirements
- g. Environmental conditions
- h. Lubrication data
- i. Preventive maintenance plan and schedule
- j. Troubleshooting guides and diagnostic techniques
- k. Wiring diagrams and control diagrams
- l. Maintenance and repair procedures
- m. Removal and replacement instructions
- n. Spare parts and supply list
- o. Corrective maintenance man-hours
- p. Parts identification
- q. Warranty information
- r. Personnel training requirements
- s. Testing equipment and special tool information
- t. Contractor information

## 1.3.5 Data Package 5

- a. Safety precautions
- b. Operator prestart
- c. Start-up, shutdown, and post-shutdown procedures
- d. Normal operations
- e. Environmental conditions
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring and control diagrams

- i. Maintenance and repair procedures
- j. Spare parts and supply list
- k. Testing equipments and special tools
- l. Warranty information
- m. Contractor information

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

-- End of Section --

## SECTION 01850

## CONTRACT DRAWINGS

03/98

## NORFOLK DISTRICT

FILE NUMBER	REVISION	TITLE
LF-450-1.001	G-001	COVER SHEET
LF-450-1.002	G-002	INDEX OF DRAWINGS
LF-450-1.003	G-003	INDEX OF DRAWINGS
LF-450-1.004	G-004	ABBREVIATIONS AND LEGENDS
LF-450-1.005	B-001	BORING LOGS
LF-450-1.006	B-002	BORING LOGS
LF-450-1.007	B-003	BORING LOGS
LF-450-1.008	C-001	SITE KEYPLAN, LEGEND, ABBREVIATIONS & GENERAL NOTES
LF-450-1.009	C-002	SITE KEYPLAN, LEGEND, ABBREVIATIONS & GENERAL NOTES
LF-450-1.010	C-101	EXISTING CONDITIONS DEMOLITION
LF-450-1.011	C-102	EXISTING CONDITIONS DEMOLITION
LF-450-1.012	C-103	EXISTING CONDITIONS DEMOLITION
LF-450-1.013	C-104	EXISTING CONDITIONS DEMOLITION
LF-450-1.014	C-105	EXISTING CONDITIONS DEMOLITION
LF-450-1.015	C-106	SITE LAYOUT AND UTILITY PLAN
LF-450-1.016	C-107	SITE LAYOUT AND UTILITY PLAN
LF-450-1.017	C-108	SITE LAYOUT AND UTILITY PLAN
LF-450-1.018	C-109	SITE LAYOUT AND UTILITY PLAN
LF-450-1.019	C-110	SITE LAYOUT AND UTILITY PLAN
LF-450-1.020	C-111	GRADING, DRAINAGE AND E & S PLAN
LF-450-1.021	C-112	GRADING, DRAINAGE AND E & S PLAN
LF-450-1.022	C-113	GRADING, DRAINAGE AND E & S PLAN
LF-450-1.023	C-114	GRADING, DRAINAGE AND E & S PLAN
LF-450-1.024	C-501	SITE DETAILS
LF-450-1.025	C-502	SITE DETAILS
LF-450-1.026	C-503	SITE DETAILS
LF-450-1.027	C-504	SITE DETAILS
LF-450-1.028	C-505	SITE DETAILS
LF-450-1.029	C-506	SITE DETAILS
LF-450-1.030	C-507	SITE DETAILS
LF-450-1.031	C-508	EROSION & SEDIMENT CONTROL DETAILS
LF-450-1.032	C-509	STORM DRAINAGE PROFILES
LF-450-1.033	C-510	STORM DRAINAGE PROFILES
LF-450-1.034	L-101	LANDSCAPE PLAN
LF-450-1.035	L-102	LANDSCAPE PLAN
LF-450-1.036	L-103	LANDSCAPE PLAN
LF-450-1.037	L-104	LANDSCAPE PLAN
LF-450-1.038	L-501	LANDSCAPE PLANTING DETAILS
LF-450-1.039	HM-100	BLDG 20 - SECOND FLOOR HAZARDOUS MATERIALS DEMOLITION PLAN
LF-450-1.040	HM-101	BLDG 21 - BASEMENT HAZARDOUS MATERIALS DEMOLITION PLAN

LF-450-1.041	HM-102	BLDG 21 - ATTIC HAZARDOUS MATERIALS DEMOLITION PLAN
LF-450-1.042	AD-100	BLDG 21 - PARTIAL FOUNDATION PLAN - DEMOLITION
LF-450-1.043	AD-101	BLDG 21 - BASEMENT PLAN - DEMOLITION
LF-450-1.044	AD-102	BLDG 21 - FIRST FLOOR PLAN - DEMOLITION
LF-450-1.045	AD-103	BLDG 21 - SECOND FLOOR PLAN - DEMOLITION
LF-450-1.046	AD-104	BLDG 18 - FLOOR PLAN - DEMOLITION
LF-450-1.047	AD-105	BUNKER AND BUILDING 20 - FLOOR PLANS - DEMOLITION
LF-450-1.048	S-001	GENERAL NOTES AND TYPICAL DETAILS
LF-450-1.049	S-002	TYPICAL DETAILS
LF-450-1.050	S-003	TYPICAL DETAILS
LF-450-1.051	S-004	TYPICAL DETAILS
LF-450-1.052	S-101	PARTIAL FOUNDATION PLAN AREA - A
LF-450-1.053	S-102	PARTIAL FOUNDATION PLAN AREA - B
LF-450-1.054	S-103	PARTIAL FOUNDATION PLAN AREA - C
LF-450-1.055	S-104	PARTIAL FOUNDATION PLAN AREA - D
LF-450-1.056	S-105	PARTIAL SECOND FLOOR FRAMING PLAN AREA - A
LF-450-1.057	S-106	PARTIAL SECOND FLOOR FRAMING PLAN AREA - B
LF-450-1.058	S-107	PARTIAL SECOND FLOOR FRAMING PLAN AREA - C
LF-450-1.059	S-108	PARTIAL SECOND FLOOR FRAMING PLAN AREA - D
LF-450-1.060	S-109	PARTIAL ATTIC FRAMING PLAN AREA - E
LF-450-1.061	S-110	PARTIAL ATTIC FRAMING PLAN AREA - F
LF-450-1.062	S-111	PARTIAL ROOF FRAMING PLAN AREA - A
LF-450-1.063	S-112	PARTIAL ROOF FRAMING PLAN AREA - B
LF-450-1.064	S-113	PARTIAL ROOF FRAMING PLAN AREA - C
LF-450-1.065	S-114	PARTIAL ROOF FRAMING PLAN AREA - D
LF-450-1.066	S-201	WINDOW FRAMING ELEVATIONS AND DETAILS
LF-450-1.067	S-202	GRIDLINE 'R' ELEVATION
LF-450-1.068	S-301	SECTIONS
LF-450-1.069	S-302	SECTIONS
LF-450-1.070	S-303	SECTIONS
LF-450-1.071	S-304	SECTIONS
LF-450-1.072	S-305	SECTIONS
LF-450-1.073	S-306	SECTIONS
LF-450-1.074	S-307	SECTIONS
LF-450-1.075	S-308	SECTIONS
LF-450-1.076	S-309	SECTIONS
LF-450-1.077	S-501	BRACED FRAME DETAILS
LF-450-1.078	S-601	SCHEDULES
LF-450-1.079	A-101	OVERALL FLOOR PLAN FIRST FLOOR
LF-450-1.080	A-102	OVERALL FLOOR PLAN SECOND FLOOR
LF-450-1.081	A-103	OVERALL FLOOR PLAN ATTIC
LF-450-1.082	A-104	OVERALL FLOOR PLAN THIRD FLOOR (OPTION 1)
LF-450-1.083	A-105	FIRST FLOOR PLAN - AREA A
LF-450-1.084	A-106	FIRST FLOOR PLAN - AREA B
LF-450-1.085	A-107	FIRST FLOOR PLAN - AREA C
LF-450-1.086	A-108	FIRST FLOOR PLAN - AREA D
LF-450-1.087	A-109	SECOND FLOOR PLAN - AREA A
LF-450-1.088	A-110	SECOND FLOOR PLAN - AREA B
LF-450-1.089	A-111	SECOND FLOOR PLAN - AREA C
LF-450-1.090	A-112	SECOND FLOOR PLAN - AREA D
LF-450-1.091	A-113	ATTIC FLOOR PLAN - AREA E
LF-450-1.092	A-114	ATTIC FLOOR PLAN - AREA F
LF-450-1.093	A-115	THIRD FLOOR PLAN - AREA E (OPTION 1)
LF-450-1.094	A-116	THIRD FLOOR PLAN - AREA F (OPTION 1)

LF-450-1.095	A-117	FIRST FLOOR REFLECTED CEILING PLAN - AREA A
LF-450-1.096	A-118	FIRST FLOOR REFLECTED CEILING PLAN - AREA B
LF-450-1.097	A-119	FIRST FLOOR REFLECTED CEILING PLAN - AREA C
LF-450-1.098	A-120	FIRST FLOOR REFLECTED CEILING PLAN - AREA D
LF-450-1.099	A-121	SECOND FLOOR REFLECTED CEILING PLAN - AREA A
LF-450-1.100	A-122	SECOND FLOOR REFLECTED CEILING PLAN - AREA B
LF-450-1.101	A-123	SECOND FLOOR REFLECTED CEILING PLAN - AREA C
LF-450-1.102	A-124	SECOND FLOOR REFLECTED CEILING PLAN - AREA D
LF-450-1.103	A-125	ATTIC FLOOR REFLECTED CEILING PLAN - AREA E
LF-450-1.104	A-126	ATTIC FLOOR REFLECTED CEILING PLAN - AREA F
LF-450-1.105	A-127	THIRD FLOOR REFLECT CEILING PLAN - AREA E (OPTION 1)
LF-450-1.106	A-128	THIRD FLOOR REFLECT CEILING PLAN - AREA F (OPTION 1)
LF-450-1.107	A-129	RAISED ACCESS FLOORING PLAN - FIRST FLOOR
LF-450-1.108	A-130	RAISED ACCESS FLOORING PLAN - SECOND FLOOR
LF-450-1.109	A-131	ROOF PLAN
LF-450-1.110	A-201	BUILDING ELEVATIONS
LF-450-1.111	A-301	BUILDING SECTIONS
LF-450-1.112	A-302	BUILDING SECTIONS
LF-450-1.113	A-303	WALL SECTIONS
LF-450-1.114	A-304	WALL SECTIONS
LF-450-1.115	A-305	WALL SECTION
LF-450-1.116	A-306	WALL SECTION
LF-450-1.117	A-307	WALL SECTION
LF-450-1.118	A-308	WALL SECTION
LF-450-1.119	A-309	WALL SECTIONS
LF-450-1.120	A-310	WALL SECTIONS
LF-450-1.121	A-311	WALL SECTION
LF-450-1.122	A-312	WALL SECTION
LF-450-1.123	A-401	ENLARGED STAIR PLANS
LF-450-1.124	A-402	ENLARGED STAIR PLANS AND SECTIONS
LF-450-1.125	A-403	STAIR SECTIONS
LF-450-1.126	A-404	ELEVATOR PLANS AND SECTIONS
LF-450-1.127	A-405	STAIR DETAILS
LF-450-1.128	A-406	STAIR DETAILS
LF-450-1.129	A-407	ELEVATOR DETAILS
LF-450-1.130	A-408	ENLARGED TOILET PLANS
LF-450-1.131	A-409	CASEWORK ELEVATIONS AND SECTIONS
LF-450-1.132	A-501	COLUMN DETAILS FIRST FLOOR
LF-450-1.133	A-502	COLUMN DETAILS FIRST FLOOR
LF-450-1.134	A-503	COLUMN DETAILS FIRST FLOOR
LF-450-1.135	A-504	COLUMN DETAILS FIRST FLOOR
LF-450-1.136	A-505	COLUMN DETAILS SECOND FLOOR
LF-450-1.137	A-506	COLUMN DETAILS SECOND FLOOR
LF-450-1.138	A-507	COLUMN DETAILS SECOND FLOOR
LF-450-1.139	A-508	COLUMN DETAILS ATTIC
LF-450-1.140	A-509	COLUMN DETAILS THIRD FLOOR (OPTION 1)
LF-450-1.141	A-510	PRECAST PANEL DETAILS
LF-450-1.142	A-511	PRECAST PANEL DETAILS
LF-450-1.143	A-512	ROOF DETAILS
LF-450-1.144	A-513	ROOF DETAILS
LF-450-1.145	A-514	ROOF DETAILS
LF-450-1.146	A-515	MISCELLANEOUS DETAILS
LF-450-1.147	A-516	MISCELLANEOUS DETAILS
LF-450-1.148	A-517	MISCELLANEOUS DETAILS
LF-450-1.149	A-518	MISCELLANEOUS DETAILS
LF-450-1.150	A-519	CANOPY SECTION & DETAILS
LF-450-1.151	A-601	FINISH SCHEDULE

LF-450-1.152	A-602	COLOR SCHEDULE
LF-450-1.153	A-603	DOOR SCHEDULE, ELEVATIONS AND NOTES
LF-450-1.154	A-604	HOLLOW METAL FRAME DOOR AND WINDOW DETAILS
LF-450-1.155	A-605	HOLLOW METAL FRAME DOOR AND WINDOW DETAILS
LF-450-1.156	A-606	HOLLOW METAL FRAME DOOR AND WINDOW DETAILS
LF-450-1.157	A-607	WINDOW SYSTEM ELEVATIONS
LF-450-1.158	A-608	EXTERIOR WINDOW & DOOR DETAILS
LF-450-1.159	A-609	EXTERIOR WINDOW & DOOR DETAILS
LF-450-1.160	A-610	EXTERIOR WINDOW & DOOR DETAILS
LF-450-1.161	A-611	EXTERIOR WINDOW & DOOR DETAILS
LF-450-1.162	A-612	GRAPHIC SIGNAGE
LF-450-1.163	A-613	GRAPHIC SIGNAGE - AREA A
LF-450-1.164	I-101	FIRST FLOOR FURNITURE PLAN - AREA A
LF-450-1.165	I-102	FIRST FLOOR FURNITURE PLAN - AREA B AND C
LF-450-1.166	I-103	FIRST FLOOR FURNITURE PLAN - AREA D
LF-450-1.167	I-104	SECOND FLOOR FURNITURE PLAN - AREA A
LF-450-1.168	I-105	SECOND FLOOR FURNITURE PLAN - AREA B AND C
LF-450-1.169	I-106	SECOND FLOOR FURNITURE PLAN - AREA D
LF-450-1.170	I-107	THIRD FLOOR FURNITURE PLAN - AREA E AND F (OPTION 1)
LF-450-1.171	F-101	FIRE PROTECTION PLAN FIRST FLOOR
LF-450-1.172	F-102	FIRE PROTECTION PLAN SECOND FLOOR
LF-450-1.173	F-103	FIRE PROTECTION PLAN ATTIC
LF-450-1.174	F-104	FIRE PROTECTION PLAN THIRD FLOOR (OPTION 1)
LF-450-1.175	F-105	LEGEND, DETAIL & MECHANICAL PART PLAN - FIRE SUPPRESSION
LF-450-1.176	P-001	LEGEND SCHEDULES NOTES AND ABBREVIATIONS
LF-450-1.177	P-201	FIRST FLOOR PLAN - AREA A - PLUMBING
LF-450-1.178	P-202	FIRST FLOOR PLAN - AREA B - PLUMBING
LF-450-1.179	P-203	FIRST FLOOR PLAN - AREA C - AND MECH. ROOM PART PLAN - PLUMBING
LF-450-1.180	P-204	FIRST FLOOR PLAN - AREA D - PLUMBING
LF-450-1.181	P-205	SECOND FLOOR PLAN - AREA A - PLUMBING
LF-450-1.182	P-206	SECOND FLOOR PLAN - AREA B - PLUMBING
LF-450-1.183	P-207	SECOND FLOOR PLAN - AREA C - PLUMBING
LF-450-1.184	P-208	SECOND FLOOR PLAN - AREA D - PLUMBING
LF-450-1.185	P-209	ATTIC FLOOR PLAN - AREA E - PLUMBING
LF-450-1.186	P-210	ATTIC FLOOR PLAN - AREA F - PLUMBING
LF-450-1.187	P-211	THIRD FLOOR PLAN - AREA E (OPTION 1) - PLUMBING
LF-450-1.188	P-212	THIRD FLOOR PLAN - AREA F (OPTION 1) - PLUMBING
LF-450-1.189	P-301	FIRST FLOOR PART PLANS - TOILET/BREAK ROOMS - PLUMBING
LF-450-1.190	P-302	SECOND FLOOR PART PLANS - TOILET/BREAK ROOMS - PLUMBING
LF-450-1.191	P-303	THIRD FLOOR PART PLANS - TOILET ROOM (OPTION 1) - PLUMBING
LF-450-1.192	P-401	RISER DIAGRAMS
LF-450-1.193	P-402	RISER DIAGRAMS
LF-450-1.194	P-501	PLUMBING DETAILS
LF-450-1.195	M-001	MECHANICAL LEGEND
LF-450-1.196	M-101	MECHANICAL SITE PLAN AND COURTYARD PLAN
LF-450-1.197	M-102	MECHANICAL DEMOLITION
LF-450-1.198	M-103	MECHANICAL DEMOLITION
LF-450-1.199	M-104	MECHANICAL DEMOLITION
LF-450-1.200	M-201	MECHANICAL FIRST FLOOR PLAN AREA A - DUCTWORK

LF-450-1.201	M-202	MECHANICAL FIRST FLOOR PLAN AREA B - DUCTWORK
LF-450-1.202	M-203	MECHANICAL FIRST FLOOR PLAN AREA C - DUCTWORK
LF-450-1.203	M-204	MECHANICAL FIRST FLOOR PLAN AREA D - DUCTWORK
LF-450-1.204	M-205	MECHANICAL SECOND FLOOR PLAN AREA A - DUCTWORK
LF-450-1.205	M-206	MECHANICAL SECOND FLOOR PLAN AREA B - DUCTWORK
LF-450-1.206	M-207	MECHANICAL SECOND FLOOR PLAN AREA C - DUCTWORK
LF-450-1.207	M-208	MECHANICAL SECOND FLOOR PLAN AREA D - DUCTWORK
LF-450-1.208	M-209	MECHANICAL ATTIC FLOOR PLAN AREA E - DUCTWORK
LF-450-1.209	M-210	MECHANICAL ATTIC FLOOR PLAN AREA F - DUCTWORK
LF-450-1.210	M-211	MECHANICAL THIRD FLOOR PLAN AREA E (OPTION 1) - DUCTWORK
LF-450-1.211	M-212	MECHANICAL THIRD FLOOR PLAN AREA F (OPTION 1) - DUCTWORK
LF-450-1.212	M-301	MECHANICAL FIRST FLOOR PLAN AREA A - PIPING
LF-450-1.213	M-302	MECHANICAL FIRST FLOOR PLAN AREA B - PIPING
LF-450-1.214	M-303	MECHANICAL FIRST FLOOR PLAN AREA C - PIPING
LF-450-1.215	M-304	MECHANICAL FIRST FLOOR PLAN AREA D - PIPING
LF-450-1.216	M-305	MECHANICAL SECOND FLOOR PLAN AREA A - PIPING
LF-450-1.217	M-306	MECHANICAL SECOND FLOOR PLAN AREA B - PIPING
LF-450-1.218	M-307	MECHANICAL SECOND FLOOR PLAN AREA C - PIPING
LF-450-1.219	M-308	MECHANICAL SECOND FLOOR PLAN AREA D - PIPING
LF-450-1.220	M-309	MECHANICAL ATTIC FLOOR PLAN AREA E - PIPING
LF-450-1.221	M-310	MECHANICAL ATTIC FLOOR PLAN AREA F - PIPING
LF-450-1.222	M-311	MECHANICAL THIRD FLOOR PLAN AREA E (OPTION 1) - PIPING
LF-450-1.223	M-312	MECHANICAL THIRD FLOOR PLAN AREA F (OPTION 1) - PIPING
LF-450-1.224	M-401	MECHANICAL ENLARGED PLANS
LF-450-1.225	M-501	MECHANICAL SCHEDULES
LF-450-1.226	M-502	MECHANICAL SCHEDULES
LF-450-1.227	M-601	MECHANICAL PIPING SCHEMATICS
LF-450-1.228	M-602	MECHANICAL DETAILS
LF-450-1.229	M-603	MECHANICAL DETAILS
LF-450-1.230	M-604	MECHANICAL DETAILS
LF-450-1.231	M-701	MECHANICAL SECTIONS
LF-450-1.232	M-702	MECHANICAL SECTIONS
LF-450-1.233	M-801	MECHANICAL DDC CONTROLS AND SEQUENCE OF OPERATIONS
LF-450-1.234	M-802	MECHANICAL DDC CONTROLS AND SEQUENCE OF OPERATIONS
LF-450-1.235	M-803	MECHANICAL DDC CONTROLS AND SEQUENCE OF OPERATIONS
LF-450-1.236	E-001	ELECTRICAL LEGEND
LF-450-1.237	E-002	EXTERIOR LEGEND AND ABBREVIATIONS
LF-450-1.238	E-003	ELECTRICAL FLOOR PLAN - BUILDING 18 - DEMOLITION - LIGHTING AND POWER
LF-450-1.239	E-004	ELECTRICAL FIRST FLOOR PLAN - BUILDING 21 - DEMOLITION - LIGHTING
LF-450-1.240	E-005	ELECTRICAL FIRST FLOOR PLAN - BUILDING 21 - DEMOLITION - POWER
LF-450-1.241	E-006	ELECTRICAL SECOND FLOOR PLAN - BUILDING 21 - DEMOLITION - LIGHTING
LF-450-1.242	E-007	ELECTRICAL SECOND FLOOR PLAN - BUILDING 21 - DEMOLITION - POWER
LF-450-1.243	E-101	MEDIUM VOLTAGE 22KV ONE LINE DIAGRAM
LF-450-1.244	E-102	ELECTRICAL SITE PLAN - DEMOLITION - POWER
LF-450-1.245	E-103	ELECTRICAL SITE PLAN - DEMOLITION - COMMUNICATIONS

LF-450-1.246	E-104	ELECTRICAL SITE PLAN PART A - NEW WORK - POWER & MECHANICAL/ELECTRICAL COURTYARD PLAN
LF-450-1.247	E-105	ELECTRICAL SITE PLAN PART B - NEW WORK - POWER
LF-450-1.248	E-106	ELECTRICAL SITE PLAN - NEW WORK - COMMUNICATIONS
LF-450-1.249	E-107	ELECTRICAL EXTERIOR DETAILS
LF-450-1.250	E-108	ELECTRICAL SITE PLAN - LIGHTING
LF-450-1.251	E-109	ELECTRICAL EXTERIOR DETAILS
LF-450-1.252	E-110	COMMUNICATIONS MANHOLE DETAILS
LF-450-1.253	E-111	POWER MANHOLE DETAILS
LF-450-1.254	E-112	OVERHEAD ELECTRICAL POLE DETAILS
LF-450-1.255	E-113	OVERHEAD ELECTRICAL POLE DETAILS
LF-450-1.256	E-114	OUTDOOR WALKIN SWITCHGEAR MSGR DETAILS AND SCHEDULE
LF-450-1.257	E-201	ELECTRICAL FIRST FLOOR PLAN AREA A - LIGHTING
LF-450-1.258	E-202	ELECTRICAL FIRST FLOOR PLAN AREA B - LIGHTING
LF-450-1.259	E-203	ELECTRICAL FIRST FLOOR PLAN AREA C - LIGHTING
LF-450-1.260	E-204	ELECTRICAL FIRST FLOOR PLAN AREA D - LIGHTING
LF-450-1.261	E-205	ELECTRICAL SECOND FLOOR PLAN AREA A - LIGHTING
LF-450-1.262	E-206	ELECTRICAL SECOND FLOOR PLAN AREA B - LIGHTING
LF-450-1.263	E-207	ELECTRICAL SECOND FLOOR PLAN AREA C - LIGHTING
LF-450-1.264	E-208	ELECTRICAL SECOND FLOOR PLAN AREA D - LIGHTING
LF-450-1.265	E-209	ELECTRICAL ATTIC FLOOR PLAN AREA E - LIGHTING
LF-450-1.266	E-210	ELECTRICAL ATTIC FLOOR PLAN AREA F - LIGHTING
LF-450-1.267	E-211	ELECTRICAL THIRD FLOOR PLAN AREA E (OPTION 1) - LIGHTING
LF-450-1.268	E-212	ELECTRICAL THIRD FLOOR PLAN AREA F (OPTION 1) - LIGHTING
LF-450-1.269	E-301	ELECTRICAL FIRST FLOOR PLAN AREA A - POWER
LF-450-1.270	E-302	ELECTRICAL FIRST FLOOR PLAN AREA B - POWER
LF-450-1.271	E-303	ELECTRICAL FIRST FLOOR PLAN AREA C - POWER
LF-450-1.272	E-304	ELECTRICAL FIRST FLOOR PLAN AREA D - POWER
LF-450-1.273	E-305	ELECTRICAL SECOND FLOOR PLAN AREA A - POWER
LF-450-1.274	E-306	ELECTRICAL SECOND FLOOR PLAN AREA B - POWER
LF-450-1.275	E-307	ELECTRICAL SECOND FLOOR PLAN AREA C - POWER
LF-450-1.276	E-308	ELECTRICAL SECOND FLOOR PLAN AREA D - POWER
LF-450-1.277	E-309	ELECTRICAL ATTIC FLOOR PLAN AREA E - POWER
LF-450-1.278	E-310	ELECTRICAL ATTIC FLOOR PLAN AREA F - POWER
LF-450-1.279	E-311	ELECTRICAL THIRD FLOOR PLAN AREA E (OPTION 1) - POWER
LF-450-1.280	E-312	ELECTRICAL THIRD FLOOR PLAN AREA F (OPTION 1) - POWER
LF-450-1.281	E-401	ELECTRICAL FIRST FLOOR PLAN AREA A - COMMUNICATIONS
LF-450-1.282	E-402	ELECTRICAL FIRST FLOOR PLAN AREA B - COMMUNICATIONS
LF-450-1.283	E-403	ELECTRICAL FIRST FLOOR PLAN AREA C - COMMUNICATIONS
LF-450-1.284	E-404	ELECTRICAL FIRST FLOOR PLAN AREA D - COMMUNICATIONS
LF-450-1.285	E-405	ELECTRICAL SECOND FLOOR PLAN AREA A - COMMUNICATIONS
LF-450-1.286	E-406	ELECTRICAL SECOND FLOOR PLAN AREA B - COMMUNICATIONS
LF-450-1.287	E-407	ELECTRICAL SECOND FLOOR PLAN AREA C - COMMUNICATIONS
LF-450-1.288	E-408	ELECTRICAL SECOND FLOOR PLAN AREA D - COMMUNICATIONS
LF-450-1.289	E-409	ELECTRICAL ATTIC FLOOR PLAN AREA E - COMMUNICATIONS

LF-450-1.290	E-410	ELECTRICAL ATTIC FLOOR PLAN AREA F - COMMUNICATIONS
LF-450-1.291	E-411	ELECTRICAL THIRD FLOOR PLAN AREA E - (OPTION 1) COMMUNICATIONS
LF-450-1.292	E-412	ELECTRICAL THIRD FLOOR PLAN AREA F - (OPTION 1) COMMUNICATIONS
LF-450-1.293	E-501	ELECTRICAL FIRST FLOOR PLAN AREA A - SPECIAL SYSTEMS
LF-450-1.294	E-502	ELECTRICAL FIRST FLOOR PLAN AREA B - SPECIAL SYSTEMS
LF-450-1.295	E-503	ELECTRICAL FIRST FLOOR PLAN AREA C - SPECIAL SYSTEMS
LF-450-1.296	E-504	ELECTRICAL FIRST FLOOR PLAN AREA D - SPECIAL SYSTEMS
LF-450-1.297	E-505	ELECTRICAL SECOND FLOOR PLAN AREA A - SPECIAL SYSTEMS
LF-450-1.298	E-506	ELECTRICAL SECOND FLOOR PLAN AREA B - SPECIAL SYSTEMS
LF-450-1.299	E-507	ELECTRICAL SECOND FLOOR PLAN AREA C - SPECIAL SYSTEMS
LF-450-1.300	E-508	ELECTRICAL SECOND FLOOR PLAN AREA D - SPECIAL SYSTEMS
LF-450-1.301	E-509	ELECTRICAL ATTIC FLOOR PLAN AREA E - SPECIAL SYSTEMS
LF-450-1.302	E-510	ELECTRICAL ATTIC FLOOR PLAN AREA F - SPECIAL SYSTEMS
LF-450-1.303	E-511	ELECTRICAL THIRD FLOOR PLAN AREA E (OPTION 1) - SPECIAL SYSTEMS
LF-450-1.304	E-512	ELECTRICAL THIRD FLOOR PLAN AREA F (OPTION 1) - SPECIAL SYSTEMS
LF-450-1.305	E-601	ELECTRICAL FIRST FLOOR PLAN AREA A - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.306	E-602	ELECTRICAL FIRST FLOOR PLAN AREA B - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.307	E-603	ELECTRICAL FIRST FLOOR PLAN AREA C - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.308	E-604	ELECTRICAL FIRST FLOOR PLAN AREA D - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.309	E-605	ELECTRICAL SECOND FLOOR PLAN AREA A - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.310	E-606	ELECTRICAL SECOND FLOOR PLAN AREA B - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.311	E-607	ELECTRICAL SECOND FLOOR PLAN AREA C - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.312	E-608	ELECTRICAL SECOND FLOOR PLAN AREA D - UNDER RAISED FLOOR CABLE TRAY
LF-450-1.313	E-609	ENLARGED SERVER FARM ROOM B100 PLAN - POWER
LF-450-1.314	E-610	ENLARGED SERVER FARM ROOM B100 PLAN - COMMUNICATIONS
LF-450-1.315	E-611	ENLARGED COMMUNICATIONS PLANS
LF-450-1.316	E-701	ELECTRICAL ONE LINE DIAGRAM - PART A
LF-450-1.317	E-702	ELECTRICAL ONE LINE DIAGRAM - PART B
LF-450-1.318	E-703	RISER DIAGRAMS - NIPRNET/PHONE UNCLASSIFIED AND SIPRINET CLASSIFIED
LF-450-1.319	E-704	RISER DIAGRAMS - CENTIX AND JWICS AND RED SWITCH
LF-450-1.320	E-705	RISER DIAGRAMS - SECURITY
LF-450-1.321	E-706	IDS ZONING DIAGRAMS
LF-450-1.322	E-707	RISER AND ZONING DIAGRAMS - SOUND MASKING SYSTEM
LF-450-1.323	E-708	RISER DIAGRAMS - FIRE ALARM AND PUBLIC ADDRESS

LF-450-1.324	E-709	GROUNDING AND WIRING DIAGRAMS
LF-450-1.325	E-710	DIAGRAMS AND DETAILS - CCTV
LF-450-1.326	E-711	FLOOR/WALL PENETRATION REQUIREMENT PLANS
LF-450-1.327	E-801	ELECTRICAL DETAILS
LF-450-1.328	E-802	ELECTRICAL DETAILS
LF-450-1.329	E-803	ELECTRICAL DETAILS
LF-450-1.330	E-804	ELECTRICAL DETAILS
LF-450-1.331	E-805	ELECTRICAL DETAILS
LF-450-1.332	E-806	ELECTRICAL DETAILS
LF-450-1.333	E-901	SWITCHBOARD SCHEDULES AND ELEVATIONS
LF-450-1.334	E-902	SWITCHBOARD SCHEDULE AND ELEVATION
LF-450-1.335	E-903	PANELBOARD SCHEDULES
LF-450-1.336	E-904	PANELBOARD SCHEDULES
LF-450-1.337	E-905	PANELBOARD SCHEDULES
LF-450-1.338	E-906	PANELBOARD SCHEDULES
LF-450-1.339	E-907	PANELBOARD SCHEDULES
LF-450-1.340	E-908	PANELBOARD SCHEDULES
LF-450-1.341	E-909	PANELBOARD SCHEDULES
LF-450-1.342	E-910	PANELBOARD SCHEDULES
LF-450-1.343	E-911	PANELBOARD SCHEDULES
LF-450-1.344	E-1001	ELECTRICAL LIGHTING DETAILS
LF-450-1.345	E-1002	ELECTRICAL LIGHTING DETAILS
LF-450-1.346	E-1101	LIGHTNING PROTECTION PLAN AND LEGEND
LF-450-1.347	E-1102	GROUNDING PLAN AND LEGEND
LF-450-1.348	E-1103	LIGHTNING PROTECTION DETAILS
LF-450-1.349	E-1104	LIGHTNING PROTECTION DETAILS
LF-450-1.350	E-1105	LEGEND, DETAIL & MECHANICAL PART PLAN - FIRE SUPPRESSION
	C-001A	COVER SHEET
	C-107A	GRADING, DRAINAGE & EROSION CONTROL PLAN
	C-108A	GRADING, DRAINAGE & EROSION CONTROL PLAN
	C-109A	GRADING, DRAINAGE & EROSION CONTROL PLAN
	C-110A	SIGNAL PLAN
	C-501A	DETAILS

-- End of Section --

## SECTION 02115A

UNDERGROUND STORAGE TANK REMOVAL  
02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referenced in the text by basic designation only.

## AMERICAN PETROLEUM INSTITUTE (API)

API Pub 2217A	(1997) Guidelines for Work in Inert Confined Spaces in the Petroleum Industry
API Pub 2219	(1999) Safe Operation of Vacuum Trucks in Petroleum Service, 2nd Edition
API RP 1604	(1996) Closure of Underground Petroleum Storage Tanks
API RP 2003	(1998) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API Std 2015	(1994) Safe Entry and Cleaning of Petroleum Storage Tanks

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2000) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996e1) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996e1) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 261	Identification and Listing of Hazardous
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## Waste

40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Work Plan; G.

The Work Plan within 30 days after notice to proceed. The Contractor shall allow 30 days in the schedule for the Government's review and approval. No adjustment for time or money will be made for resubmittals required as a result of noncompliance.

Qualifications; G.

A document indicating that the Contractor meets the specified requirements.

Salvage Rights; G FIO.

A record of the disposition of salvaged materials at the end of the contract.

## SD-06 Test Reports

Backfill Material; G.

Tank Contents Verification; G.

Contaminated Water Disposal; G.

Soil Examination, Testing, and Analysis; G.

Reports including the chain-of-custody records.

Backfilling; G.

Copies of all laboratory and field test reports.

Tank Closure Report; G.

Three copies of the report for each UST site opened, prepared in a standard 3-ring binder, within 14 days of completing work at each site. Each binder shall be labeled with contract number, project name, location and tank number; each binder shall be indexed. A copy of the report shall be furnished to the Installation Environmental Coordinator.

### 1.3 QUALIFICATIONS

The Contractor shall have a minimum of 2 years of tank removal experience and shall be certified by the State of Virginia for tank removal work.

#### 1.3.1 Laboratory Services

For laboratory services the Contractor shall be validated in accordance with state certification requirements.

#### 1.3.2 Support Staff

The Contractor shall identify all staff involved for the various components, including personnel collecting and shipping samples. The qualifications of these staff members shall be detailed by the Contractor.

### 1.4 REGULATORY REQUIREMENTS

#### 1.4.1 Permits and Licenses

The Contractor, as required or as directed by the Contracting Officer, shall obtain local, state, or federal permits and licenses that directly impact the Contractor's ability to perform the work prior to commencing removal operations.

#### 1.4.2 Statutes and Regulations

Tank closures shall be carried out in accordance with 40 CFR 280, 40 CFR 262, 40 CFR 264, and 40 CFR 265 as well as the applicable City of Hampton and State of Virginia regulations. Petroleum contaminated waste shall be transported in accordance with State of Virginia Regulations.

### 1.5 PROJECT/SITE CONDITIONS

The work shall consist of removal, decontamination and disposal of two, 1,000 gallon underground storage tank and associated piping and ancillary equipment. The tanks are constructed of steel and are at the location shown on the drawings. The 1,000 gallon tank at Building 18 was used for storing fuel oil and was taken out of service in 1995. The 1,000 gallon fuel oil tank at Building 21 is in active use. Residue remaining in the tanks is considered a petroleum contaminated waste. Existing native soils are predominantly clayey sand. Groundwater has been encountered within 8 feet of the surface. The Contractor shall verify the actual conditions

prior to submitting a bid. The site is not a hazardous waste site but shall be given special consideration due to the nature of the materials and hazards present until closure activities are complete.

#### 1.5.1 Sequencing and Scheduling

The Contractor shall notify the Installation Environmental Coordinator 764-1129 and the Contracting Officer 10 days prior to tank removal. The Contractor shall be responsible for contacting the Implementation Agency (IA) in accordance with the applicable reporting requirements.

#### 1.5.2 Work Plan

The Contractor shall develop, implement, maintain, and supervise as part of the work, a comprehensive plan for tank removal and related operations. As a minimum the plan shall include, but not be limited to, excavation, removal, and ultimate disposal of the tank, its contents, and any contaminated materials. The Work Plan shall be based on work experience, on the requirements of this specification, and on the following references:

- a. API RP 1604.
- b. API Std 2015.
- c. API RP 2003.
- d. API Pub 2217A.
- e. API Pub 2219.

No work at the site, with the exception of site inspections and mobilization, shall be performed until the Work Plan is approved. At a minimum, the Work Plan shall include:

- a. Discussion of the removal approach, tank cleaning, and tank cutting procedures.
- b. A Sampling and Analysis Plan prepared in accordance with Section 01450A CHEMICAL DATA QUALITY CONTROL.
- c. Methods to be employed for product, sludge, vapor, and pumpable liquid removal; purging and inerting; and storage methods proposed for control of surface water.
- d. Treatment options.
- e. Identification of waste, tank and contaminated soil transporters and means of transportation.
- f. Treatment, disposal, and alternate facilities, and means of treatment, disposal or remediation.
- g. Borrow source.
- h. Spill prevention plan.
- i. Spill contingency plan.
- j. Decontamination procedures, shoring plan, and safety measures in

accordance with Section 01351A SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

## PART 2 PRODUCTS

### 2.1 BACKFILL MATERIAL

Backfill material shall be obtained from off-site. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, or SC, and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. If off-site materials are used, soil classification test results shall be approved prior to bringing the material onsite. The testing frequency for backfill material shall be 1 per 1000 cubic yards or a minimum of 1 test. Non-contaminated material removed from the excavation shall be used for backfill in accordance with Paragraph BACKFILLING.

## PART 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

#### 3.1.1 Safety Guidelines

Personnel shall abide by the safety guidelines specified in Section 01351A SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

#### 3.1.2 Burning and Explosives

Use of explosives or burning debris will not be allowed.

#### 3.1.3 Protection of Existing Structures and Utilities

The Contractor shall take all necessary precautions to avoid damage to existing structures, their appurtenances, monitoring wells, or utilities that may be affected by work activities. Any damage to utilities resulting from the Contractor's operations shall be repaired at no expense to the Government. The Contractor shall coordinate with the installation to locate underground utilities prior to beginning construction. Utilities encountered which were not previously shown or otherwise located shall not be disturbed without approval from the Contracting Officer.

#### 3.1.4 Shoring

Shoring requirements shall be provided in accordance with Section 01351A SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

### 3.2 TANK CONTENTS VERIFICATION

Sampling and analysis shall be conducted in accordance with the approved Sampling and Analysis Plan and Section 01450A CHEMICAL DATA QUALITY CONTROL.

#### 3.2.1 Sampling

Tank product shall be sampled by the Contractor. If the data is not adequate, additional sampling and analysis to the extent required by the approved permitted treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor. Meeting all regulatory requirements, including the preparation of hazardous materials and waste for transportation shall be the responsibility of the Contractor.

### 3.2.2 Analysis

Tank contents shall be tested by the Contractor for the parameters listed herein. Analyses shall include total petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene and xylene (BETX), lead Diesel Range Organics (DRO) and Gasoline Range Organics (GRO).

### 3.2.3 Characterization

Prior to removing any of the tank contents, the contents shall be characterized to determine if the tank contents must be disposed as a hazardous waste based on local, state, and Federal disposal regulations. Tank product, pumpable liquids, and sludge shall be characterized in accordance with 40 CFR 261 and 40 CFR 279. The waste contents determination and accompanying test results for each phase present in the tank shall be submitted to the Contracting Officer.

### 3.3 CLEARING, GRUBBING AND REMOVALS

Clearing and grubbing shall be in accordance with Section 02230A CLEARING AND GRUBBING as required and directed by the Contracting Officer shall be cleared of all trees, stumps, down timber, brush, rubbish, roots larger than 3 inches in diameter, and matted roots prior to commencing operations. Concrete or asphalt pavement shall be saw cut at the limits of removal, broken and removed with the resulting debris disposed off Government Property.

### 3.4 TOPSOIL

Uncontaminated topsoil shall be stripped and stockpiled separately for reuse at the location shown if it meets the requirements of clean fill given in Paragraph BACKFILLING. Additional topsoil in excess of that produced by excavation shall be obtained off-site. All areas disturbed by tank removal operations, other than areas to receive pavement or similar surface under this contract, shall be topsoiled.

### 3.5 PREPARATIONS FOR EXCAVATION

Before excavating, the Contractor shall drain product piping back to the tank, remove residual liquids trapped in the product lines and remove all product from the tank; and the tank shall be purged and vented in accordance with API RP 1604, and as specified herein.

#### 3.5.1 Removal of Product, Pumpable Liquids, and Sludge

Tank product, pumpable liquids, and sludge shall be contained, and stored onsite, prior to disposal. Contaminated water shall be treated as specified. Tank product, pumpable liquids, and sludge shall be analyzed and segregated to recover reusable products by the Contractor prior to being transported to the treatment, storage and disposal (TSD) facility. The Contractor shall be responsible for obtaining all required permits. Usable product shall be the property of the Contractor. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal restriction notices and notifications, necessary for accomplishment of the work, including materials necessary for cleaning up spills that could occur from tank removal operations.

### 3.5.2 Contaminated Water Disposal

#### 3.5.2.1 Sampling, Analysis, and Containment

Contaminated water shall be sampled and analyzed both prior to and after treatment. Analysis for contaminated water to be taken to an off-site treatment facility shall conform to the requirements of the treatment facility with documentation of all analyses performed furnished to the Contracting Officer in accordance with paragraph RECORDS. Contaminated water shall be contained, stored onsite, and analyzed and disposed of by the Contractor in accordance with applicable Federal and state disposal regulations. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal notices and notifications, necessary for accomplishment of the work. Sampling and analyses of contaminated water and treated water and the Contractor and laboratory quality assurance program shall be in accordance with Section 01450A CHEMICAL DATA QUALITY CONTROL.

#### 3.5.2.2 Treatment

Contaminated water shall be treated off-site by oil water separation filtering and activated carbon or other means as approved by the Contracting Officer. If contaminated water is to be treated onsite, the proposed treatment shall be specified in the Work Plan and submitted for approval. Temporary storage and treatment equipment shall be installed in the general vicinity of the tanks at a location approved by the Contracting Officer.

### 3.6 PURGING AND INERTING

After the tank and piping contents have been removed, but prior to excavation beyond the top of the tank, the Contractor shall disconnect all the piping (except the piping needed to purge or inert the tank). Flammable and toxic vapors shall be purged from the tank or the tank made inert in accordance with API RP 1604, with the exceptions that filling with water shall not be used and, if dry ice is employed, the Contractor shall use a minimum of 3 pounds per 100 gallons of tank volume. The tank atmosphere shall be continuously monitored for combustible vapors if the tank is purged, or continuously monitored for oxygen if the tank is inerted.

### 3.7 EXCAVATION

Excavation areas, as well as work near roadways, shall be marked in accordance with Section 01351A SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

#### 3.7.1 Exploratory Trenches

Exploratory trenches shall be excavated as necessary to determine the tank location, limits and the location of ancillary equipment.

#### 3.7.2 Tank Excavation

Excavation around the perimeter of the tank shall be performed limiting the amount of potentially petroleum contaminated soil that could be mixed with previously uncontaminated soil. Petroleum contaminated soil shall be segregated in separate stockpiles. The Contractor shall maintain around the tank an excavation of sufficient size to allow workers ample room to complete the work, but also protect the workers from sliding or cave-ins.

Sheeting, bracing, or shoring shall be installed in the absence of adequate side slopes if there is a need for workers to enter the excavated area. Surface water shall be diverted to prevent direct entry into the excavation. Dewatering of the excavation may require a discharge permit by the State and shall be limited to allow adequate access to the tank and piping, to assure a safe excavation, and to ensure that compaction and moisture requirements are met during backfilling. Dewatering may result in the production of petroleum contaminated water and/or free product. Free product shall be recovered from the groundwater only as part of necessary dewatering.

### 3.7.3 Piping Excavation

Excavation shall be performed as necessary to remove tank piping and ancillary equipment in accordance with paragraphs: Shoring, Tank Excavation, and Open Excavations.

### 3.7.4 Open Excavations

Open excavations and stockpile areas shall be secured while awaiting confirmation test results from the soil beneath the tank. The excavation shall be backfilled as soon as possible after tank and contaminated soil removals have been completed and confirmation samples have been taken. The Contractor shall divert surface water around excavations to prevent water from directly entering into the excavation.

### 3.7.5 Stockpiles

Uncontaminated excavated soil and petroleum contaminated soil that is not a state-regulated hazardous waste shall be stockpiled and used for backfill in the tank excavation prior to using borrow material. Excavated material that is regulated by the state as a hazardous waste which is visibly stained and which has an obvious petroleum odor or as required by the State of Virginia or implementing agency shall be considered contaminated and shall be placed in containers such as drums, roll-offs or dumpsters for sampling in accordance with paragraph Stockpiled Material Sampling. Uncontaminated soil shall be stockpiled separately from the contaminated soil, a safe distance away from, but adjacent to, the excavation. Allowable stockpiles of contaminated soil shall be placed on an impermeable geomembrane a minimum of 3 layers, each 30 mils thick, and covered with a 10 mils sheet of geomembrane as specified. The geomembrane shall be placed to prevent the stockpiled soil from coming into contact with surface water run-off. The geomembrane cover shall prevent rain or surface water from coming into contact with the contaminated soil, as well as limit the escape of the volatile constituents in the stockpile.

## 3.8 REMOVAL OF PIPING, ANCILLARY EQUIPMENT, AND TANK

### 3.8.1 Piping and Ancillary Equipment

All piping and ancillary equipment shall be disconnected from the tank. The piping shall be removed to the exterior surface of the tank, where it shall be capped and abandoned in place or as directed by the Contracting Officer. All tank ancillary equipment and piping connections shall be capped, except those connections necessary to inert the tank within the excavation zone. The piping exterior and ancillary equipment shall be cleaned to remove all soil and inspected for signs of corrosion and leakage. The Contractor shall ensure no spillage of the piping contents occurs, as specified in the Work Plan, and as required in paragraph SPILLS.

If the soil under and around the tank pad is contaminated, the tank pad shall be removed and disposed of off-site at an approved non-hazardous, hazardous waste facility.

### 3.8.2 Tank

The tank shall be removed from the excavation and the exterior cleaned to remove all soil and inspected for signs of corrosion, structural damage, or leakage. All materials coming into contact with the tank, or in the vicinity of the excavation such as shovels, slings and tools shall be of the non-sparking type. After removal from the excavation, the tank shall be placed on a level surface at an approved location and secured with wood blocks to prevent movement.

### 3.8.3 Contaminated Soil, Tank and Piping Excavation Examination

After the tank has been removed from the ground, the adjacent and underlying soil shall be examined for any evidence of leakage. The soil shall be visually inspected for staining after removal of all obviously contaminated soil, then screened for the presence of volatile and/or semi-volatile contamination using a real time vapor monitoring instrument. Uncontaminated soil or petroleum contaminated soil not regulated by the state as hazardous waste shall be stockpiled onsite per paragraph Stockpiles.

Contaminated soil or suspected contaminated soil shall be containerized, or, if the site is a RCRA-designated CAMU, stockpiled until further disposition. The Contracting Officer shall determine the extent of the contaminated soil to be removed from each site but shall not exceed 10, 13 cubic yards per site. The Contractor shall report any evidence indicating that the amount of contaminated soil may exceed the individual site limit specified, to the Contracting Officer the same day it is discovered. If minimal additional excavation is required, the Contracting Officer may allow the Contractor to proceed. If extensive contamination is encountered, the excavation shall be sampled and backfilled in accordance with paragraph BACKFILLING. After the known contaminated soil is removed, the excavation shall be sampled and analyzed in accordance with Section 01450A CHEMICAL DATA QUALITY CONTROL.

## 3.9 TANK CLEANING

### 3.9.1 Exterior

Soil shall be removed from the exterior of the tank, piping, and associated equipment to eliminate soil deposition on roadways during transportation to a temporary storage area, ensure markings will adhere to the surfaces, and simplify tank cutting. Soil shall be removed using non-sparking tools. Removed uncontaminated soil and soil not regulated by the state as a hazardous waste shall be recovered and used as backfill in the former tank excavation or disposed of onsite. Soil believed to be contaminated shall be removed and containerized, or if the site is a RCRA designated CAMU, collected on 3 layers of 30 mil impermeable geomembrane and stockpiled with other contaminated soil removed from the excavation.

### 3.9.2 Temporary Storage

If the tank is stored after the tank exterior is cleaned and ancillary equipment is removed, and prior to being cut into sections, the tank shall be labeled as directed in API RP 1604, placed on blocks, and temporarily stored in the area of the existing tank site. Prior to cleaning the tank interior the tank atmosphere shall be monitored for combustible vapors and

purged or inerted if combustible vapors are detected.

### 3.9.3 Interior

The tank interior shall be cleaned using a high pressure (greater than 500 psi), low volume (less than 2 gpm) water spray or steam cleaned until all loose scale and sludge is removed, and contamination, in the form of a sheen, is no longer visible in the effluent stream. The interior surfaces of piping shall also be cleaned, to the extent possible, using the same method used for cleaning the tank. Contaminated water generated from interior cleaning operations (of both piping and tank) shall not exceed the following quantities for each UST cleaned:

UST VOLUME (GALLONS)	PERCENT OF UST VOLUME
1,000 or less	5
10,000 or less	5 or 100 gal., whichever is less
20,000 or less	1 or 150 gal., whichever is less
greater than 20,000	1 or 250 gal., whichever is less

All contaminated water resulting from cleaning operations shall be handled in accordance with paragraph Contaminated Water Disposal. Cleaning shall be accomplished eliminating, to the greatest extent possible, the need for personnel to enter the tank. Cleaning shall be done using specially designed tank cleaning equipment which allows the tank to be cleaned prior to cutting into sections without requiring personnel to enter the tank or, if less specialized equipment is used, the tank shall be partially dissected to overcome confined space entry hazards. This work shall be accomplished in accordance with Section 01351A SAFETY, HEALTH, AND EMERGENCY RESPONSE (HTRW/UST).

## 3.10 SOIL EXAMINATION, TESTING, AND ANALYSIS

### 3.10.1 Tank Excavation Sampling Procedures

After soil known to be contaminated has been removed or after soil excavation is complete, the excavation shall be sampled with procedures, number, location, and methodology in accordance with state regulations and Section 01450A CHEMICAL DATA QUALITY CONTROL. Samples shall be obtained from the pits using a backhoe with a Shelby tube attached to the bucket. Sample preservation and analytical procedures shall conform to Section 01450A CHEMICAL DATA QUALITY CONTROL.

### 3.10.2 Stockpiled Material Sampling

Sampling locations, number and specific procedures shall be as required by the State of Virginia and the disposal facility.

### 3.10.3 Analysis

Soil samples from the excavation and stockpiled material shall be tested in accordance with the approved Sampling and Analysis Plan, and Section 01450A CHEMICAL DATA QUALITY CONTROL for the following parameters: total petroleum hydrocarbon (TPH), benzene, ethylbenzene, toluene, xylene (BETX) the following constituents: Diesel Range Organics (DRO) and Gasoline Range Organics (GRO). Copies of all test results shall be provided to the Contracting Officer.

## 3.11 BACKFILLING

The tank area and any other excavations shall be backfilled only after the soil test results have been approved. Contaminated soil removal shall be complete after the bottom of the tank excavation is determined to have soil contamination levels below the state standards of 100 ppm TPH. The excavation shall be dewatered if necessary. Stockpiled material subjected to chemical confirmation testing shall be used as backfill if it is found to conform to the requirements of clean fill per appropriate state regulations. Backfill consisting of clean fill shall be placed in layers with a maximum loose thickness of 8 inches, and compacted to 90 percent maximum density for cohesive soils and 95 percent maximum density for cohesionless soils. Density tests shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor.

Test results shall be attached to contractor's Quality Control Report. A minimum of 1 density test shall be performed on every third lift. Laboratory tests for moisture density relations shall be determined in accordance with ASTM D 1557, Method B, C, or D, or ASTM D 3017. A mechanical tamper may be used provided that the results are correlated with those obtained by the hand tamper. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2922, or ASTM D 2167.

### 3.12 DISPOSAL REQUIREMENTS

#### 3.12.1 Treatment, Disposal, and Recycling

Disposal of hazardous wastes shall be in accordance with all local, State, and Federal solid and hazardous waste laws and regulations; the RCRA; and conditions specified herein. This work shall include all necessary personnel, labor, transportation, packaging, detailed analyses (if required for disposal, manifesting or completing waste profile sheets), equipment, and reports. Product and pumpable liquids removed from the tank shall be recycled to the greatest extent practicable. The tanks removed shall be disposed of at one of the state approved facilities. Each tank disposed of in this manner shall be manifested as required by the State of Virginia to document delivery and acceptance at the disposal facility.

#### 3.12.2 Tank and Ancillary Equipment Disposal

After the tank, piping, and ancillary equipment have been removed from the excavation and the tank cleaned, the tank shall be cut into sections with no dimension greater than 5 feet. Tank and piping sections shall be disposed of in a State approved off-site disposal facility or in a salvage yard. The tank shall be cut into sections prior to being taken off Government property. The Contractor shall not sell the tank intact. Ancillary equipment shall be disposed of at an approved off-site disposal facility. Piping shall be disconnected from the tank and removed unless otherwise indicated.

#### 3.12.3 Transportation of Wastes

Transportation shall be provided in accordance with Department of Transportation (DOT) Hazardous Material Regulations and State and local requirements, including obtaining all necessary permits, licenses, and approvals. Evidence that a State licensed petroleum contaminated waste transporter is being used shall be included in the SUBMITTALS.

#### 3.12.4 Salvage Rights

The Contractor shall retain the rights to salvage value of recycled or

reclaimed product and metal not turned in to the DRMO or otherwise identified, so long as the requirements of 40 CFR 266 and 40 CFR 279, or the applicable State requirements are met. At the end of the contract, the Contractor shall provide documentation on the disposition of salvaged materials.

### 3.12.5 Records

Records shall be maintained of all waste determinations, including appropriate results of analyses performed, substances and sample location, the time of collection, and other pertinent data as required by 40 CFR 280, Section 74 and 40 CFR 262 Subpart D, and Section 01450A CHEMICAL DATA QUALITY CONTROL. Transportation, treatment, disposal methods and dates, the quantities of waste, the names and addresses of each transporter and the disposal or reclamation facility, shall also be recorded and available for inspection, as well as copies of the following documents:

- a. Manifests.
- b. Waste analyses or waste profile sheets.
- c. Certifications of final treatment/disposal signed by the responsible disposal facility official.
- d. Land disposal notification records required under 40 CFR 268 for hazardous wastes.

Records shall be provided in accordance with Section 02120A TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS. Following contract close out, the records shall become the property of the Government.

### 3.12.6 Hazardous/Special Waste Manifests

Manifesting shall conform to the requirements of the State of Virginia.

### 3.12.7 Documentation of Treatment or Disposal

The wastes, other than recyclable or reclaimable product or metal, shall be taken to a treatment, storage, or disposal facility which has EPA or appropriate state permits and petroleum contaminated waste identification numbers and complies with the provisions of the disposal regulations. The original return copy of the hazardous waste manifest, signed by the owner or operator of a facility legally permitted to treat or dispose of those materials shall be furnished to the Contracting Officer not later than 5 working days following the delivery of those materials to the facility; and a copy shall be included in the Tank Closure Report. A statement of agreement from the proposed treatment, storage or disposal facility and certified transporters to accept hazardous or special wastes shall be furnished in the Work Plan to the Contracting Officer not less than 14 days before transporting any wastes. If the Contractor selects a different facility than is identified in the Work Plan, documentation shall be provided for approval to certify that the facility is authorized and meets the standards specified in 40 CFR 264.

### 3.13 SPILLS

Immediate containment actions shall be taken as necessary to minimize effect of any spill or leak. Cleanup shall be in accordance with applicable Federal, State, local laws and regulations, and district policy

at no additional cost to the Government. Refer to Section 02120A TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS for spill response and reporting requirements.

### 3.14 TANK CLOSURE REPORT

Tank Closure Reports shall include the following information as a minimum:

- a. A cover letter signed by a responsible company official certifying that all services involved have been performed in accordance with the terms and conditions of this specification.
- b. A narrative report describing what was encountered at each site, including:
  - (1) condition of the UST.
  - (2) any visible evidence of leaks or stained soils.
  - (3) results of vapor monitoring readings.
  - (4) actions taken including quantities of materials treated or removed.
  - (5) reasons for selecting sample locations.
  - (6) sample locations.
  - (7) collection data such as time of collection and method of preservation.
  - (8) reasons for backfilling site.
  - (9) whether or not groundwater was encountered.
- c. Copies of all analyses performed for disposal.
- d. Copies of all waste analyses or waste profile sheets.
- e. Copies of all certifications of final disposal signed by the responsible disposal installation official.
- f. Information on who sampled, analyzed, transported, and accepted all wastes encountered, including copies of manifests, waste profile sheets, land disposal restriction, notification and certification forms, certificates of disposal, and other pertinent documentation.
- g. Copies of all analyses performed for confirmation that underlying soil is not contaminated, with copies of chain-of-custody for each sample. Analyses shall give the identification number of the sample used. Sample identification numbers shall correspond to those provided on the one-line drawings.
- h. Scaled one-line drawings showing tank locations, limits of excavation, limits of contamination, underground utilities within 50 feet, sample locations, and sample identification numbers.
- i. Progress Photographs. The Contractor shall take a minimum of 4 views of the site showing such things as the location of each tank,

entrance/exit road, and any other notable site condition before work begins. After work has been started at the site, the Contractor shall photographically record activities at each work location daily. Photographs shall be 3 x 5 inches and shall include:

- (1) Soil removal, handling, and sampling.
- (2) Unanticipated events such as discovery of additional contaminated areas.
- (3) Soil stockpile area.
- (4) Tank.
- (5) Site or task-specific employee respiratory and personal protection.
- (6) Fill placement and grading.
- (7) Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four (4) views of the site. Prints shall illustrate the condition and location of work and the state of progress. The photographs shall be mounted and enclosed back-to-back in a double face plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, 1-1/2 x 3-1/2 inches. The information box for the 3 x 5 inch photographs shall be scaled down accordingly, or taped to the bottom of the photo. The box shall be typewritten and arranged as follows:

Project No.	Contract No.
Location	
Contractor/Photographer	
Photograph No.	Date/Time:
Description	
Direction of View	

-- End of Section --

## SECTION 02220

## DEMOLITION

05/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.6 (1990) Safety Requirements for Demolition Operations

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline K (1997) Containers for Recovered Fluorocarbon Refrigerants

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61-SUBPART M National Emission Standard for Asbestos

40 CFR 82 Protection of Stratospheric Ozone; Refrigerant Recycling

49 CFR 173.301 Shipment of Compressed Gas Cylinders

## U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA 4145.25 (June 2000) Storage and Handling of Liquefied and Compressed Gases and Their Full and Empty Cylinders

## U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M Requisitioning and Issue Procedures

MIL-STD-129 (Rev. N) Marking for Shipment and Storage

## U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual

## 1.2 GENERAL REQUIREMENTS

Do not begin demolition until authorization is received from the Contracting Officer. Remove rubbish and debris from the station daily; do not allow accumulations inside or outside the buildings. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be

stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible (in accordance with Section 01572 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT, if applicable; salvaged items and materials shall be disposed of as specified.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

##### Work Plan

The procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in accordance with EM 385-1-1.

#### SD-07 Certificates

Demolition plan; G

Notifications; G

Submit proposed demolition and removal procedures to the Contracting Officer for approval before work is started.

### 1.4 REGULATORY AND SAFETY REQUIREMENTS

Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," safety requirements shall conform with ANSI A10.6.

#### 1.4.1 Notifications

Furnish timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61-SUBPART M. Notify the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61-SUBPART M.

### 1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris to occupied building on airfield pavements and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable

conditions such as, but not limited to, ice, flooding, or pollution.

## 1.6 PROTECTION

### 1.6.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights.

### 1.6.2 Existing Work

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement must have Contracting Officer approval.

### 1.6.3 Trees

Trees within the project site which might be damaged during demolition, and which are indicated to be left in place, shall be protected by a 6 foot high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Contracting Officer.

### 1.6.4 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Contracting Officer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

### 1.6.5 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other

structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

#### 1.7 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

#### 1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by the Contracting Officer.

#### 1.9 Required Data

Demolition plan shall include procedures for coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations.

#### 1.10 Environmental Protection

The work shall comply with the requirements of Section 01560 ENVIRONMENTAL PROTECTION (PROJECT SITE).

#### 1.11 USE OF EXPLOSIVES

Use of explosives will not be permitted.

### PART 2 PRODUCTS

Not used.

### PART 3 EXECUTION

#### 3.1 EXISTING FACILITIES TO BE REMOVED

##### 3.1.1 Structures

Existing structures indicated shall be removed in their entirety. Interior walls, retaining walls and partitions, shall be removed in their entirety. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

##### 3.1.2 Utilities and Related Equipment

Remove existing utilities, as indicated or as uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area. Remove meters and related equipment and deliver to a location on the station in accordance with instructions of the Contracting Officer.

##### 3.1.3 Paving and Slabs

Sawcut concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 6 inches below existing adjacent grade. Provide neat sawcuts at limits of pavement removal as indicated.

#### 3.1.4 Air Conditioning Equipment

Remove air conditioning equipment without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990. Recover all refrigerants prior to removing air conditioning equipment and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

#### 3.1.5 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

#### 3.1.6 Locksets on Swinging Doors

The Contractor shall remove all security hardware locksets from all swinging doors indicated to be removed and disposed of. Contractor shall give the locksets to the Contracting Officer after their removal.

### 3.2 FILLING

Holes, open basements and other hazardous openings shall be filled in accordance with Section 02300 EARTHWORK and Section 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

### 3.3 DISPOSITION OF MATERIAL

#### 3.3.1 Title to Materials

Except where specified in other sections or as indicated on drawings, all materials and building mechanical, electrical, plumbing system equipment removed, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition and removal procedures, and authorization by the Contracting Officer to begin demolition. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

Government shall salvage prior to turning buildings over to Contractor all loose furniture and work equipment (i.e. computers, fax machines, copies, etc.). Government shall also salvage built-in electrical equipment such as video projectors, cameras, etc.

#### 3.3.2 Reuse of Materials and Equipment

Remove and store materials and equipment indicated to be reused or relocated to prevent damage, and reinstall as the work progresses.

#### 3.3.3 Salvaged Materials and Equipment

Contractor shall salvage items and material to the maximum extent possible.

Material salvaged for the Contractor shall be stored as approved by the

Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents. The following items reserved as property of the Government shall be delivered to the areas designated: Security hardware, transformers, generator, and medium voltage switch.

The following items reserved as property of the using service shall be removed prior to commencement of work under this contract: All loose furniture and work equipment (i.e. computers, fax machines, copiers, etc.) Government shall also salvage built-in electrical equipment such as video projectors, cameras, etc.. Security hardware locksets shall also be turned over to the Contracting Officer in accordance with paragraph "Locksets and Swinging Doors."

Historical items shall be removed in a manner to prevent damage. The following historical items shall be delivered to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

Remove and capture all Class I ODS refrigerants in accordance with the Clean Air Act Amendment of 1990, and turn in to the Government as directed by the Commanding Officer.

#### 3.3.4 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting ARI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS shall be turned over to the Contracting Officer. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.

##### 3.3.4.1 Special Instructions

Each container shall have in it no more than one type of ODS. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

- a. Activity name and unit identification code
- b. Activity point of contact and phone number
- c. Type of ODS and pounds of ODS contained
- d. Date of shipment
- e. Naval stock number (for information, call (804) 279-4525).

#### 3.3.4.2 Fire Suppression Containers

Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

#### 3.3.5 Transportation Guidance

Shipment of all ODS containers shall be in accordance with MIL-STD-129, DLA 4145.25 (also referenced one of the following: Army Regulation 700-68, Naval Supply Instruction 4440.128C, Marine Corps Order 10330.2C, and Air Force Regulation 67-12), 49 CFR 173.301, and DOD 4000.25-1-M.

#### 3.3.6 Unsalvageable Material

Concrete, masonry, and other noncombustible material shall be disposed of offsite at Contractor's expense. Combustible material shall be disposed of in the sanitary fill area located off of Government property at Contractor's expense.

### 3.4 CLEANUP

Debris and rubbish shall be removed from basement and similar excavations. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

#### 3.4.1 Debris and Rubbish

Debris and rubbish shall be removed from basement and similar excavations. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

-- End of Section --

## SECTION 02231

## CLEARING AND GRUBBING

07/02

## PART 1 GENERAL

## 1.1 DELIVERY, STORAGE, AND HANDLING

Deliver materials to, store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

## 3.1 PROTECTION

## 3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

## 3.1.2 Trees, Shrubs, and Existing Facilities

Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

## 3.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Contracting Officer in ample time to minimize interruption of the service.

## 3.2 CLEARING

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint.

### 3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

### 3.4 PRUNING

Trim trees designated to be left standing within the cleared areas of dead branches 1 1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1 1/4 inches in diameter with an approved tree wound paint.

### 3.5 GRUBBING

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

### 3.6 DISPOSAL OF MATERIALS

#### 3.6.1 Nonsaleable Materials

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, except for salable timber, shall be disposed of outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed.

-- End of Section --

RMS SUBMITTAL REGISTER INPUT FORM			CONTRACT NUMBER		DELIVERY ORDER														
OPERATIONS SUPPORT CENTER, LANGLEY AFB, VA																			
SECTION	PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL								CLASSIFICATION		REVIEWING OFFICE						
			01 - PRECON SUBMITTALS	02 - SHOP DRAWINGS	03 - PRODUCT DATA	04 - SAMPLES	05 - DESIGN DATA	06 - TEST REPORTS	07 - CERTIFICATES	08 - MFRS INSTRUCTIONS	09 - MFRS FIELD REPORT	10 - O&M DATA	11 - CLOSEOUT SUBMITTALS	FOR INFORMATION ONLY	GOVERNMENT APPROVED	DO - DISTRICT OFFICE	AO - AREA OFFICE	RO - RESIDENT OFFICE	PO - PROJECT OFFICE
16710	1.5	SUBMITTALS																	X
	1.5.1	SPARE PARTS LISTS			6							X							
	1.5.2	PREMISES DISTRIBUTION SYSTEM DRAWINGS			6								X						X
	1.5.3	RECORD KEEPING DOCUMENTATION											X						X
	1.5.3.1	CABLES			6								X						X
	1.5.3.2	TERMINATION HARDWARE			6								X						X
																			X
	1.5.4	MANUFACTURER'S RECOMMENDATIONS							6				X						X
	1.5.5	TEST PLAN							6				X						X
	1.5.6	QUALIFICATIONS							6				X						X
	1.5.7	TEST REPORT							6				X						X
	1.5.8	CERTIFICATION							6				X						X
	1.5.8.1	PREMISES DISTRIBUTION SYSTEM							6				X						X
	1.5.8.2	MATERIALS AND EQUIPMENT							6				X						X
	1.7	OPERATIONS AND MAINTENANCE MANUAL									6		X						X
16175	1.4	SUBMITTALS											X						X
	1.4	Shop Drawings			6								X						X
	1.4	SD-01 DATA																	X
	1.4	Manufacturer Catalog Data			6								X						X
	1.4	Storage Batteries			6								X						X
	1.4	Voltage Drop			6								X						X
	1.4	Spare Parts			6								X						X
	1.4	SD-04 RECORD DRAWINGS																	X
	1.4	Record Drawing Software			6								X						X
	1.4	SD-08 STATEMENTS																	X
	1.4	Testing							6				X						X
	1.4	SD-09 REPORTS																	X
	1.4	Testing							6				X						X
	1.4	SD-13 CERTIFICATES																	X
	1.4	Equipment							6				X						X
	1.4	Qualifications							6				X						X
	1.4	SD-19 OPERATION and MAINTENANCE MANUALS									6		X						X

## SECTION 02300A

EARTHWORK  
12/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

- AASHTO T 180 (1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457 mm (18-in) Drop
- AASHTO T 224 (1996) Correction for Coarse Particles in the Soil Compaction Test

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 136 (1996a) Sieve Analysis of Fine and Coarse Aggregates
- ASTM D 422 (1963; R 1998) Particle-Size Analysis of Soils
- ASTM D 1140 (1997) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
- ASTM D 1556 (1990; R 1996e1) Density and Unit Weight of Soil in Place by the Sand-Cone Method
- ASTM D 1557 (1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
- ASTM D 2167 (1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- ASTM D 2487 (1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D 2922 (1996e1) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 2937 (1994) Density of Soil in Place by the Drive-Cylinder Method
- ASTM D 3017 (1988; R 1996e1) Water Content of Soil and

## Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 4318 (1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

## 1.2 DEFINITIONS

## 1.2.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, . Satisfactory materials for grading shall be comprised of stones less than 8 inches, except for fill material for pavements and railroads which shall be comprised of stones less than 3 inches in any dimension.

## 1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Contracting Officer shall be notified of any contaminated materials.

## 1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

## 1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be expressed as a percentage of the maximum density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224. To maintain the same percentage of coarse material, the "remove and replace" procedure as described in the NOTE 8 in Paragraph 7.2 of AASHTO T 180 shall be used.

## 1.2.5 Topsoil

Material suitable for topsoils obtained from offsite areas shall consist of natural friable, loamy soil free of roots, hard lumps, stiff clay, stones, or other litter.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Earthwork;

Procedure and location for disposal of unused satisfactory material.  
Proposed source of borrow material.

Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

SD-06 Test Reports

Testing;

Within 24 hours of conclusion of physical tests, 7 copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates

Testing;

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

1.4 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.5 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.6 UTILIZATION OF EXCAVATED MATERIALS

Unsatisfactory materials removed from excavations shall be disposed of in waste disposal or spoil areas off government property. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

### 3.1 STRIPPING OF TOPSOIL

Where indicated or directed, topsoil shall be stripped to a depth of 4 inches. Topsoil shall be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from excavations and grading shall be removed from the site. Stockpiled material shall be surrounded with a silt fence.

### 3.2 EARTHWORK

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Such excavated material and the satisfactory material ordered as replacement shall be included in excavation. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas.

During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

#### 3.2.1 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 4 feet from the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

#### 3.2.2 Drainage Structures

Excavations shall be made to the lines, grades, and elevations shown, or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm, level, stepped, or serrated surface. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to

the final grade level shall not be made until just before the concrete or masonry is to be placed.

### 3.3 SELECTION OF BORROW MATERIAL

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties.

Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

### 3.4 GRADING AREAS

Where indicated, work will be divided into grading areas within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. The Contractor shall not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing.

### 3.5 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Ground surface on which backfill is to be placed shall be prepared as specified in paragraph PREPARATION OF GROUND SURFACE FOR EMBANKMENTS. Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR EMBANKMENTS, EMBANKMENTS, and SUBGRADE PREPARATION, and Section 02630 STORM-DRAINAGE SYSTEM; and Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

### 3.6 PREPARATION OF GROUND SURFACE FOR EMBANKMENTS

#### 3.6.1 General Requirements

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disked, or otherwise broken up to a depth of 6 inches; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

### 3.6.2 Frozen Material

Embankment shall not be placed on a foundation which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment) and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Contracting Officer and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill shall cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for his determination. Embankment material shall not contain frozen clumps of soil, snow, or ice.

## 3.7 EMBANKMENTS

### 3.7.1 Earth Embankments

Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. The material shall be placed in successive horizontal layers of loose material not more than 8 inches in depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph SUBGRADE PREPARATION. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

## 3.8 SUBGRADE PREPARATION

### 3.8.1 Construction

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. After rolling, the surface of the subgrade for roadways shall not show deviations greater than 1/2 inch when tested with a 10 foot straightedge applied both parallel and at right angles to the centerline of

the area. The elevation of the finish subgrade shall not vary more than 0.05 foot from the established grade and cross section.

### 3.8.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, each layer of the embankment shall be compacted to at least 90 percent of laboratory maximum density.

#### 3.8.2.1 Subgrade for Pavements

Subgrade for pavements shall be compacted to at least 95 percentage laboratory maximum density for 8 inches below the surface of the pavement shown. When more than one soil classification is present in the subgrade, the top 15 inches of subgrade shall be scarified, windrowed, thoroughly blended, reshaped, and compacted.

### 3.9 FINISHING

The surface of excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in paragraph SUBGRADE PREPARATION. Gutters and ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

### 3.10 PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2 inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 4 inches and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from offsite areas.

### 3.11 TESTING

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937, Drive Cylinder Method shall be used only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer, that compaction

is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

#### 3.11.1 Fill and Backfill Material Gradation

One test per 100 cubic yards stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C 136, ASTM D 422, ASTM D 1140.

#### 3.11.2 In-Place Densities

- a. One test per 5,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
- b. One test per 1,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.
- c. One test per 200 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.

#### 3.11.3 Moisture Contents

In the stockpile, excavation, or borrow areas, a minimum of two tests per day per type of material or source of material being placed during stable weather conditions shall be performed. During unstable weather, tests shall be made as dictated by local conditions and approved by the Contracting Officer.

#### 3.11.4 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 1,000 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

#### 3.11.5 Tolerance Tests for Subgrades

Continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION shall be made during construction of the subgrades.

### 3.12 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subbase, base course, ballast,

or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

-- End of Section --

## SECTION 02315A

EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS  
08/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

## 1.2 DEGREE OF COMPACTION

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, abbreviated as percent laboratory maximum density.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-06 Test Reports

## Testing

Copies of all laboratory and field test reports within 24 hours of the completion of the test. In addition to required number of submittals, send one copy of all test reports directly to the Contracting Officer for information and record purposes.

## 1.4 SUBSURFACE CONDITIONS

Refer to specification Section 01055, "Soil Boring Data" for information concerning boring logs. A copy of the boring logs are shown in the drawing set.

## PART 2 PRODUCTS

## 2.1 MATERIALS

## 2.1.1 Satisfactory Materials

Satisfactory materials shall be as follows:

- a. Select fill beneath floor slabs shall comprise of materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SC, SP-SM or better and free of debris.
- b. Select granular fill beneath footings shall comprise of materials classified by ASTM D 2487 as SP, SM, SP-SM or better material with less than 20 percent passing the No. 200 sieve and free of debris.
- c. Fill in other areas shall comprise of materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SC or better material and free of debris.
- d. Satisfactory material in-situ shall consists of any of the satisfactory materials listed above plus materials classified by ASTM D 2487 as CL, ML, CH, or MH.

## 2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 1.5 inches in any direction. The Contracting Officer shall be notified of any contaminated materials.

## 2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic.

## 2.2 CAPILLARY WATER BARRIER (POROUS FILL)

Capillary Water Barrier shall consist of clean granular material having a maximum particle size of 1-1/2 inches and no more than 15 percent by

weight shall pass the No. 200 size sieve (GM, GW, GP, SM, SW, SP). Size No. 57 stone per VDOT R&B Section 203 is acceptable as capillary water barrier material.

### PART 3 EXECUTION

#### 3.1 CLEARING AND GRUBBING

Clearing and grubbing is specified in Section 02231 CLEARING AND GRUBBING.

#### 3.2 TOPSOIL

Topsoil shall be stripped to a depth of 4 inches below existing grade within the designated excavations and grading lines and deposited in storage piles for later use. Excess topsoil shall be disposed as specified for excess excavated material.

#### 3.3 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified, and shall include trenching for utility and foundation drainage systems to a point 5 feet beyond the building line of each building and structure, excavation for all work incidental thereof. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms.

Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed; and payment will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES, except that no payment will be made for the removal and replacement of unsatisfactory material resulting from the action or inaction of the Contractor. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced, at no additional cost to the Government, with satisfactory materials to the indicated excavation grade; except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Satisfactory material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

#### 3.4 DRAINAGE AND DEWATERING

##### 3.4.1 Drainage

Surface water shall be directed away from excavation and construction sites to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

##### 3.4.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of

construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 2 feet below the working level.

### 3.5 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving. Any sheet pile shoring required shall be designed by a registered professional engineer and shall be submitted to the Contracting Officer for review and approval prior to installation.

### 3.6 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered.

### 3.7 BLASTING

Blasting will not be permitted.

### 3.8 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

### 3.9 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained as specified in Section 02300 EARTHWORK.

### 3.10 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Section 02300 EARTHWORK.

### 3.11 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is to be placed.

### 3.12 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to plus or minus 3 percent of optimum moisture. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

### 3.13 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Satisfactory materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness, or 6 inches when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill shall not be placed in wet or frozen areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

	Percent Laboratory maximum density	
	Cohesive material	Cohesionless material
<u>Fill, embankment, and backfill</u>		
Under structures, building slabs, steps, paved areas, around footings, and in trenches	90	95
Under sidewalks and grassed areas	85	90
<u>Subgrade</u>		
Under building slabs, steps, and paved areas, top 12 inches	90	95
Under sidewalks, top 6 inches	85	90

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping.

3.14 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937 shall be used only for soft, fine-grained, cohesive soils. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.14.1 In-Place Densities

In-place density and moisture content test results shall be included with the Contractor's daily construction quality control reports.

#### 3.14.1.1 In-Place Density of Subgrades

One test per 1000 square foot or fraction thereof.

#### 3.14.1.2 In-Place Density of Fills and Backfills

One test per 5000 square foot or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, building perimeters or other structures or areas less than 3 feet in width, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than 1000 square feet, or one test for each 100 linear foot of long narrow fills 200 feet or more in length. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows: One check per lift for each 100 linear feet of long narrow fills, and a minimum of 3 checks per lift for other fill and backfill areas.

#### 3.14.2 Moisture Content

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216.

#### 3.14.3 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material, including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 50 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density will be made.

#### 3.15 CAPILLARY WATER BARRIER (POROUS FILL)

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor for gravel material; or as required for fill and backfill for sand material.

#### 3.16 GRADING

Areas within 5 feet outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

#### 3.17 SPREADING TOPSOIL

Areas outside the building lines from which topsoil has been removed shall be topsoiled. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 2 inches by disking or plowing for the bonding of topsoil with the subsoil. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, slopes shown, and left free of surface irregularities. Topsoil shall be compacted by one pass of a cultipacker, roller, or other approved equipment weighing 100 to 160 pounds per linear foot of roller. Topsoil shall not be placed when the subgrade is frozen,

excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading.

3.18 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades reestablished to the required elevations and slopes.

-- End of Section --

## SECTION 02316A

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS  
05/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R1996e1) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

## 1.2 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Field Density Tests;  
Testing of Backfill Materials;

Copies of all laboratory and field test reports within 24 hours

of the completion of the test.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP.

#### 2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 4 inches. The Contracting Officer shall be notified of any contaminated materials.

#### 2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials shall include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

#### 2.1.4 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

#### 2.1.5 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

#### 2.1.6 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 3 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

#### 2.1.7 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 3 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

## 2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

## 2.3 Detection Wire For Non-Metallic Piping

Detection wire shall be insulated single strand, solid copper with a minimum diameter of 12 AWG.

## PART 3 EXECUTION

### 3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site.

Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

#### 3.1.1 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 3 feet high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than 6 feet high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture

content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

#### 3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

#### 3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

#### 3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

#### 3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

#### 3.1.2 Stockpiles

Stockpiles of satisfactory and unsatisfactory shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no

additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

### 3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

#### 3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall not be backfilled until all specified tests are performed.

##### 3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

##### 3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.

##### 3.2.1.3 Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

##### 3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

- a. Roadways, Railroads, and Airfields: Backfill shall be placed up to the elevation at which the requirements in Section 02300 EARTHWORK control. Water flooding or jetting methods of compaction will not be permitted.
- b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils.

#### 3.2.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been

constructed and the concrete has been allowed to cure for 2 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

### 3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

#### 3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 24 inches of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02556 GAS DISTRIBUTION SYSTEM.

#### 3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 3 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. For fire protection yard mains or piping, an additional 4 inches of cover is required.

#### 3.3.3 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

#### 3.3.4 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown.

### 3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

#### 3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer.

#### 3.4.2 Testing of Backfill Materials

Classification of backfill materials shall be determined in accordance with ASTM D 2487 and the moisture-density relations of soils shall be determined in accordance with ASTM D 1557. A minimum of one soil classification and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

#### 3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 325 feet of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic yards of material used. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

#### 3.4.4 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to the finished grade surface, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

-- End of Section --

## SECTION 02364A

TERMITICIDE TREATMENT MEASURES FOR SUBTERRANEAN TERMITE CONTROL  
06/98

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Termiticide Application Plan; G

Termiticide application plan with proposed sequence of treatment work with dates and times. The termiticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area/volume treated, amount applied; and the name and state license number of the state certified applicator shall be included.

## Termiticides; G

Manufacturer's label and Material Safety Data Sheet (MSDS) for termiticides proposed for use.

## Foundation Exterior

Written verification that other site work will not disturb the treatment.

## Utilities and Vents

Written verification that utilities, vents have been located.

## Crawl and Plenum Air Spaces

Written verification that crawl spaces and plenum air spaces have been located.

## Verification of Measurement

Written verification that the volume of termiticide used meets the application rate.

## Application Equipment

A listing of equipment to be used.

## SD-04 Samples

## Termiticides

Termiticide samples obtained during application, upon request.

### SD-06 Test Reports

#### Equipment Calibration and Tank Measurement

Certification of calibration tests conducted on the equipment used in the termiticide application.

#### Soil Moisture

Soil moisture test result.

### SD-07 Certificates

#### Qualifications

Qualifications and state license number of the termiticide applicator.

## 1.2 QUALIFICATIONS

The Contractor's principal business shall be pest control. The Contractor shall be licensed and the termiticide applicators certified in the state where the work is to be performed. Termiticide applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

## 1.3 SAFETY REQUIREMENTS

The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Use the clothing and personal protective equipment specified on the labeling for use during all phases of the application.

## 1.4 DELIVERY, STORAGE, AND HANDLING

### 1.4.1 Delivery

Termiticide material shall be delivered to the site in the original unopened containers bearing legible labels indicating the EPA registration number and manufacturer's registered uses. All other materials to be used on site for the purpose of termite control shall be delivered in new or otherwise good condition as supplied by the manufacturer or formulator.

### 1.4.2 Storage

Materials shall be stored in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

### 1.4.3 Handling

Termiticides shall be handled in accordance with manufacturer's labels. Manufacturer's warnings and precautions shall be observed. Materials shall be handled preventing contamination by dirt, water, and organic material.

Protect termiticides from sunlight as recommended by the manufacturer.

#### 1.5 INSPECTION

Termiticides shall be inspected upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDE. Each label shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Other materials shall be inspected for conformance with specified requirements. Unacceptable materials shall be removed from the job site.

#### 1.6 WARRANTY

The Contractor shall provide a 5-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual inspections of the buildings or building additions.

### PART 2 PRODUCTS

#### 2.1 TERMITICIDES

Termiticides shall be currently registered by the EPA. Termiticide shall be selected for maximum effectiveness and duration after application. The selected termiticide shall be suitable for the soil and climatic conditions at the project site.

### PART 3 EXECUTION

#### 3.1 TECHNICAL REPRESENTATIVE

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for subterranean termites. They may be present during treatment application.

#### 3.2 SITE PREPARATION

Site preparation shall be in accordance with Sections 02230 CLEARING AND GRUBBING, 02300 EARTHWORK, 02315 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS. Work related to final grades, landscape plantings, foundations, or any other alterations to finished construction which might alter the condition of treated soils, shall be coordinated with this specification.

##### 3.2.1 Ground Preparation

Food sources shall be eliminated by removing debris from clearing and grubbing and post construction wood scraps such as ground stakes, form boards, and scrap lumber from the site, before termiticide application begins.

##### 3.2.2 Verification

Before work starts, the Contractor shall verify that final grades are as indicated and smooth grading has been completed in accordance with Section 02300 EARTHWORK. Soil particles shall be finely graded with particles no larger than 1 inch and compacted to eliminate soil movement to the greatest degree.

### 3.2.3 Foundation Exterior

The Contractor shall provide written verification that final grading and landscape planting operations will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

### 3.2.4 Utilities and Vents

The Contractor shall provide written verification that the location and identity of HVAC ducts and vents, water and sewer lines, and plumbing have been accomplished prior to the termiticide application.

### 3.2.5 Crawl and Plenum Air Spaces

The Contractor shall provide written verification that the location and identity of crawl and plenum air spaces have been accomplished prior to the termiticide application.

## 3.3 SITE CONDITIONS

The following conditions shall determine the time of application.

### 3.3.1 Soil Moisture

Soils to be treated shall be tested immediately before application. Soil moisture content shall be tested to a minimum depth of 3 inches. The soil moisture shall be as recommended by the termiticide manufacturer. The termiticide will not be applied when soil moisture exceeds manufacturer's recommendations because termiticides do not adhere to the soil particles in saturated soils.

### 3.3.2 Runoff and Wind Drift

Termiticide shall not be applied during or immediately following heavy rains. Applications shall not be performed when conditions may cause runoff or create an environmental hazard. Applications shall not be performed when average wind speed exceeds 10 miles per hour. The termiticide shall not be allowed to enter water systems, aquifers, or endanger humans or animals.

#### 3.3.2.1 Vapor Barriers and Waterproof Membranes

Termiticide shall be applied prior to placement of a vapor barrier or waterproof membrane.

#### 3.3.2.2 Utilities and Vents

Prior to application, HVAC ducts and vents located in treatment area shall be turned off and blocked to protect people and animals from termiticide.

### 3.3.3 Placement of Concrete

Concrete covering treated soils shall be placed as soon as the termiticide has reached maximum penetration into the soil. Time for maximum penetration shall be as recommended by the manufacturer.

## 3.4 TERMITICIDE TREATMENT

### 3.4.1 Equipment Calibration and Tank Measurement

Immediately prior to commencement of termiticide application, calibration tests shall be conducted on the application equipment to be used and the application tank shall be measured to determine the volume and contents. These tests shall confirm that the application equipment is operating within the manufacturer's specifications and will meet the specified requirements. The Contractor shall provide written certification of the equipment calibration test results within 1 week of testing.

#### 3.4.2 Mixing and Application

Formulating, mixing, and application shall be performed in the presence of the Contracting Officer or the technical representative. A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying termiticides shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

#### 3.4.3 Treatment Method

For areas to be treated, the Contractor shall establish complete and unbroken vertical and/or horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas which serve as crawl spaces or for use as a plenum air space.

##### 3.4.3.1 Surface Application

Surface application shall be used for establishing horizontal barriers. Surface applicants shall be applied as a coarse spray and provide uniform distribution over the soil surface. Termiticide shall penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer.

##### 3.4.3.2 Rodding and Trenching

Rodding and trenching shall be used for establishing vertical soil barriers. Trenching shall be to the depth of the foundation footing. Width of trench shall be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Immediately after termiticide has reached maximum penetration as recommended by the manufacturer, backfilling of the trench shall commence. Backfilling shall be in 6 inch rises or layers. Each rise shall be treated with termiticide.

##### 3.4.4 Sampling

The Contracting Officer may draw from stocks at the job site, at any time and without prior notice, samples of the termiticides used to determine if the amount of active ingredient specified on the label is being applied.

#### 3.5 VERIFICATION OF MEASUREMENT

Once termiticide application has been completed, tank contents shall be measured to determine the remaining volume. The total volume measurement of used contents for the application shall equal the established application rate for the project site conditions. The Contractor shall

provide written verification of the measurements.

### 3.6 CLEAN UP, DISPOSAL, AND PROTECTION

Once application has been completed, the Contractor shall proceed with clean up and protection of the site without delay.

#### 3.6.1 Clean Up

The site shall be cleaned of all material associated with the treatment measures, according to label instructions, and as indicated. Excess and waste material shall be removed and disposed off site.

#### 3.6.2 Disposal of Termiticide

The Contractor shall dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

#### 3.6.3 Protection of Treated Area

Immediately after the application, the area shall be protected from other use by erecting barricades and providing signage as required or directed. Signage shall be placed inside the entrances to crawl spaces and shall identify the space as treated with termiticide and not safe for children and animals.

### 3.7 CONDITIONS FOR SATISFACTORY TREATMENT

#### 3.7.1 Equipment Calibrations and Measurements

Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

#### 3.7.2 Testing

Should an analysis, performed by a third party, indicate that the samples of the applied termiticide contain less than the amount of active ingredient specified on the label, and/or if soils are treated to a depth less than specified or approved, re-treatment will be required.

#### 3.7.3 Disturbance of Treated Soils

Soil and fill material disturbed after treatment shall be re-treated before placement of slabs or other covering structures.

#### 3.7.4 Termites Found Within the Warranty Period

If live subterranean termite infestation or termite damage is discovered during the warranty period, the Contractor shall re-treat the site.

### 3.8 RE-TREATMENT

Where re-treatment is required, the Contractor shall:

- a. Re-treat the soil and/or perform other treatment as necessary for prevention or elimination of subterranean termite infestation.

b. Repair damage caused by termite infestation.

-- End of Section --

## SECTION 02510A

## WATER DISTRIBUTION SYSTEM

05/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

## ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
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AWWA B301 (1992) Liquid Chlorine

AWWA C104 (1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C110 (1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids

AWWA C111 (1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C153 (1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. through 64 In. (1,400 mm through 1,600 mm) for Water Service

AWWA C500 (1993; C500a) Metal-Sealed Gate Valves for Water Supply Service

AWWA C502 (1994; C502a) Dry-Barrel Fire Hydrants

AWWA C504 (1994) Rubber-Seated Butterfly Valves

AWWA C509 (1994; Addendum 1995) Resilient-Seated Gate Valves for Water Supply Service

AWWA C900 (1997; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution

AWWA C905 (1997) Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.

AWWA M23 (1980) Manual: PVC Pipe - Design and Installation

## ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA Work Practices (1988) Recommended Work Practices for A/C Pipe

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24 (1995) Installation of Private Fire Service Mains and Their Appurtenances

NFPA 49 (1994) Hazardous Chemicals Data

NFPA 325-1 (1994) Fire Hazard Properties of Flammable

## Liquids, Gases, and Volatile Solids

NFPA 704 (1996) Identification of the Fire Hazards of Materials for Emergency Response

## NSF INTERNATIONAL (NSF)

NSF 14 (1998) Plastics Piping Components and Related Materials

## THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21 (1991) White or Colored Silicone Alkyd Paint

SSPC Paint 25 (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)

## 1.2 PIPING

This section covers water distribution and service lines, and connections to building service at a point approximately 5 feet outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

## 1.2.1 Service Lines

Piping for water service lines less than 3 inches in diameter shall be polyvinyl chloride (PVC) plastic, or copper tubing, unless otherwise shown or specified. Piping for water service lines 3 inches and larger shall be polyvinyl chloride (PVC) plastic, unless otherwise shown or specified.

## 1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 3 inches or larger shall be polyvinyl chloride (PVC) through 36 inch nominal diameter plastic.

## 1.2.3 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 5 foot line.

## 1.2.4 Plastic Piping System

Plastic piping system components PVC, intended for transportation of potable water shall comply with NSF 14 and be legibly marked with their symbol.

## 1.2.5 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation;

The manufacturer's recommendations for each material or procedure to be utilized.

SD-06 Test Reports

Bacteriological Disinfection;

Test results from commercial laboratory verifying disinfection.

SD-07 Certificates

Installation;

A statement signed by the manufacturer's field representative certifying that the Contractor's personnel are capable of properly installing the pipe on the project.

1.4 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

1.4.1 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Plastic Pipe

2.1.1.1 PVC Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

a. Pipe Less Than 4 inch Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure psi	Minimum Hydrostatic Pressure psi
26	100	133
21	120	160
17	150	200
13.5	200	266

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure.

b. Pipe 4 through 12 inch Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.

c. Pipe 14 through 36 inch Diameter: Pipe shall conform to AWWA C905 unless otherwise shown or specified.

2.1.2 Copper Tubing

Copper tubing shall conform to ASTM B 88, Type K, annealed.

2.2 FITTINGS AND SPECIALS

2.2.1 PVC Pipe System

a. For pipe less than 4 inch diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings; fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467; and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111.

Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.

- b. For pipe 4 inch diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 150 psi pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

#### 2.2.2 Copper Tubing System

Fittings and specials shall be flared and conform to ASME B16.26.

### 2.3 JOINTS

#### 2.3.1 Plastic Pipe Jointing

##### 2.3.1.1 PVC Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

#### 2.3.2 Copper Tubing Jointing

Joints shall be compression-pattern flared and shall be made with the specified fittings.

### 2.4 VALVES

#### 2.4.1 Gate Valves

Gate valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

- a. Valves smaller than 3 inches shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.
- b. Valves 3 inches and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.
- c. Resilient-Seated Gate Valves: For valves 3 to 12 inches in size, resilient-seated gate valves shall conform to AWWA C509.

#### 2.4.2 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves shall conform to the performance requirements of AWWA C504. Wafer type valves conforming to the performance requirements of AWWA C504 in all respects, but not meeting laying length

requirements will be acceptable if supplied and installed with a spacer providing the specified laying length. All tests required by AWWA C504 shall be met. Flanged-end valves shall be installed in an approved pit and provided with a union or sleeve-type coupling in the pit to permit removal.

Mechanical-end valves 3 through 10 inches in diameter may be direct burial if provided with a suitable valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Valve operators shall restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

#### 2.4.3 Vacuum and Air Relief Valves

Vacuum and air relief valves shall be of the size shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

#### 2.4.4 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post.

### 2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

### 2.6 FIRE HYDRANTS

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 5 inches in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 8 inches above the ground grade. Hydrants shall have a 6 inch bell connection, two 2-1/2 inch hose connections and one 4-1/2 inch pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with 1 coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and 2 finish coats of silicone alkyd paint conforming to SSPC Paint 21, of the installation's standard colors or as directed by the Contracting Officer. Suitable bronze adapter for the 4-1/2 inch each outlet, with caps, shall be furnished.

### 2.7 MISCELLANEOUS ITEMS

#### 2.7.1 Service Stops

Service stops shall be water-works inverted-ground-key type, oval or round

flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 200 psi.

#### 2.7.2 Service Boxes

Service boxes shall be concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of size shown to completely cover the service stop or valve and shall be complete with identifying covers.

#### 2.7.3 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

##### 3.1.2 Adjacent Facilities

###### 3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 10 feet each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 2 feet above the sewer main. Joints in the sewer main, closer horizontally than 3 feet to the crossing, shall be encased in concrete.

###### 3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

###### 3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

#### 3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 12 inches shall be maintained between pipes.

#### 3.1.2.5 Structures

Where water pipe is required to be installed within 3 feet of existing structures, the water pipe shall be sleeved as required in Paragraph "Casing Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

#### 3.1.3 Joint Deflection

##### 3.1.3.1 Allowable for Reinforced Concrete Pipe

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for reinforced concrete pipe unless a lesser amount is recommended by the manufacturer. Long radius curves in reinforced concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflection does not exceed the maximum recommended by the pipe manufacturer. Short radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated specials specified.

##### 3.1.3.2 Offset for Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

#### 3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

### 3.1.4.1 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA Work Practices.

### 3.1.4.2 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

### 3.1.5 Jointing

#### 3.1.5.1 PVC Plastic Pipe Requirements

- a. Pipe less than 4 inch diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with ASTM F 477 and as specified. Pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.
- b. Pipe 4 through 12 inch diameter: Joints shall be elastomeric gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 4 inch diameter with configuration using elastomeric ring gasket.
- c. Pipe 14 through 36 inch diameter: Joints shall be elastomeric gasket push-on joints made in accordance with AWWA M23.

#### 3.1.5.2 Copper Tubing Requirements

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

#### 3.1.5.3 Bonded Joints Requirements

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

#### 3.1.5.4 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

#### 3.1.6 Installation of Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 5 feet outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes. Service lines shall be constructed in accordance with the following requirements:

##### 3.1.6.1 Service Lines Larger than 50 mm (2 Inches)

Service lines larger than 2 inches shall be connected to the main by a tapped saddle, tapping sleeve and valve, service clamp or reducing tee, depending on the main diameter and the service line diameter, and shall have a gate valve. Lines 3 inches and larger may use rubber-seated butterfly valves as specified above, or gate valves.

##### 3.1.6.2 Service Lines for Sprinkler Supplies

Water service lines used to supply building sprinkler systems for fire protection shall be connected to the water distribution main in accordance with NFPA 24.

#### 3.1.7 Setting of Fire Hydrants, Meters, Valves and Valve Boxes

##### 3.1.7.1 Location of Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 6 inch branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 18 inches above the finished surrounding grade, and the operating nut not more than 48 inches above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 18 inches above the finished surrounding grade, the top of the hydrant not more than 24 inches above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished grade immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 4 inches thick and 15 inches square. Not less than 7 cubic feet of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

##### 3.1.7.2 Location of Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief

valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 4 feet on all sides of the box, or the undisturbed trench face if less than 4 feet.

#### 3.1.7.3 Location of Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

#### 3.1.8 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

#### 3.1.9 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 4 inches in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

##### 3.1.9.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2,000 psi after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

#### 3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

##### 3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 200 psi. Water supply lines designated on the drawings shall be subjected for 1 hour to a hydrostatic pressure test of 200 psi. Each valve shall be opened and closed several times during the test.

Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

- a. Wet or unstable soil conditions in the trench.
- b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.
- c. Maintaining the trench in an open condition would delay completion of the project.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 200 psi pressure. Water supply lines designated on the drawings shall be subjected to a pressure equal to 200 psi. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$$L = 0.0001351ND(P \text{ raised to } 0.5 \text{ power})$$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

### 3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure

test and subsequent leakage test.

#### 3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

- a. Pressure test and leakage test may be conducted concurrently.
- b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

### 3.3 BACTERIAL DISINFECTION

#### 3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as specified. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. The agent shall not be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. Valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times. From several points in the unit, personnel from the Contractor's commercial laboratory shall take at least 3 water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

### 3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --



## SECTION 02531

## SANITARY SEWERS

07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

- ACPA 01-102 (1988) Concrete Pipe Handbook  
ACPA 01-103 (1995) Concrete Pipe Installation Manual

AMERICAN RAILWAY ENGINEERING & MAINTENANCE-OF-WAY ASSOCIATION  
(AREMA)

- AREMA 1-5 (2001) Pipelines

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 74 (1998) Cast Iron Soil Pipe and Fittings  
ASTM A 746 (1999) Ductile Iron Gravity Sewer Pipe  
ASTM C 150 (2002) Portland Cement  
ASTM C 270 (2001a) Mortar for Unit Masonry  
ASTM C 443 (2001) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets  
ASTM C 478 (1997) Precast Reinforced Concrete Manhole Sections  
ASTM C 478M (1997) Precast Reinforced Concrete Manhole Sections (Metric)  
ASTM C 564 (1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings  
ASTM C 76 (2000) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe  
ASTM C 923 (2000) Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals  
ASTM C 924 (1989; R 1997) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method  
ASTM C 94 (1994) Ready-Mixed Concrete \*\*

ASTM C 94/C 94M	(2000e2) Ready-Mixed Concrete
ASTM C 969	(2000) Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 990	(2001a) Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealers
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1999) Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2235	(2001) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2241	(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2321	(2000) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2001) Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2001) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2680	(2001) Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2751	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 2996	(2001) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(2001) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3034	(2000) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic

## Pipes Using Flexible Elastomeric Seals

ASTM D 3262	(2002) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D 3350	(2002) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3753	(1999) Glass-Fiber-Reinforced Manholes
ASTM D 3840	(2001) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM D 4161	(2001) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F 402	(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 714	(2001) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2001a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

## AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1999) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C153	(2000) Ductile-Iron Compact Fittings for Water Service
AWWA C600	(1999) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C900	(1997) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for

## Water Distribution

- AWWA M23 (1980) Manual: PVC Pipe - Design and Installation
- ASME INTERNATIONAL (ASME)
- ASME B1.20.1 (1983; R 2001) Pipe Threads, General Purpose, Inch
- CAST IRON SOIL PIPE INSTITUTE (CISPI)
- CISPI 301 (2000) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- CISPI 310 (1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- U.S. GENERAL SERVICES ADMINISTRATION (GSA)
- FS A-A-60005 (1998) Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole ++
- U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
- 29 CFR 1910.27 Fixed Ladders
- UNI-BELL PVC PIPE ASSOCIATION (UBPPA)
- UBPPA UNI-B-3 (1992) Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch)
- UBPPA UNI-B-6 (1990) Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe

## 1.2 SYSTEM DESCRIPTION

## 1.2.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals of concrete pipe, ductile-iron pipe, acrylonitrile-butadiene-styrene (ABS) composite plastic pipe or polyvinyl chloride (PVC) plastic pipe at the Contractor's option. Provide building connections of cast iron soil pipe, concrete pipe, acrylonitrile-butadiene-styrene (ABS) solid-wall plastic pipe or polyvinyl chloride (PVC) plastic pipe at the Contractor's option.

Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

## 1.3 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 5 feet outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02316A EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Precast concrete manhole; G, FIO

Metal items; G, FIO

Frames, covers, and gratings; G, FIO

##### SD-03 Product Data

Pipeline materials including joints, fittings, and couplings; G, FIO

Submit manufacturer's standard drawings or catalog cuts.

##### SD-07 Certificates

Portland Cement; G, FIO

Certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

##### 1.5.1 Delivery and Storage

##### 1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets

under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

#### 1.5.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

#### 1.5.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03300N, "Cast-In-Place Concrete."

#### 1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

### PART 2 PRODUCTS

#### 2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

##### 2.1.1 Cast-Iron Soil Piping

###### 2.1.1.1 Cast-Iron Hub and Spigot Soil Pipe and Fittings

ASTM A 74, service, with ASTM C 564 compression-type rubber gaskets.

###### 2.1.1.2 Cast-Iron Hubless Soil Pipe and Fittings

CISPI 301 with CISPI 310 coupling joints.

##### 2.1.2 Concrete Gravity Sewer Piping

###### 2.1.2.1 Concrete Gravity Pipe and Fittings

Pipe shall be reinforced concrete pipe conforming to ASTM C 76, Class II. Circular pipe with elliptical reinforcement shall have a readily visible line at least 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the top of the pipe. Fittings and specials shall conform to the applicable requirements specified for the pipe and shall be of the same strength as the pipe. Cement used in manufacturing pipe and fittings shall be Type II conforming to ASTM C 150.

###### 2.1.2.2 Jointing Materials for Concrete Gravity Piping

Gaskets and pipe ends for rubber gasket joint shall conform to ASTM C 443. Gaskets shall be suitable for use with sewage.

##### 2.1.3 Ductile Iron Gravity Sewer Pipe and Associated Fittings

###### 2.1.3.1 Ductile Iron Gravity Pipe and Fittings

Ductile iron pipe shall conform to ASTM A 746, Thickness Class 0.125. Fittings shall conform to AWWA C110 or AWWA C153. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends. Fittings shall have strength at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the joints specified hereinafter. Pipe and fittings shall have cement-mortar lining conforming to AWWA C104, standard thickness.

#### 2.1.3.2 Ductile Iron Gravity Joints and Jointing Materials

Pipe and fittings shall have push-on joints or mechanical joints, except as otherwise specified in this paragraph. Mechanical joint requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to AWWA C111.

#### 2.1.4 ABS Composite Plastic Piping

##### 2.1.4.1 ABS Composite Plastic Pipe and Fittings

ASTM D 2680.

##### 2.1.4.2 Jointing Materials for ABS Composite Plastic Piping

Solvent cement and primer shall conform to ASTM D 2680.

#### 2.1.5 ABS Solid-Wall Plastic Piping

##### 2.1.5.1 ABS Solid-Wall Plastic Pipe and Fittings

ASTM D 2751, SDR 35, with ends suitable for either solvent cement joints or elastomer joints.

##### 2.1.5.2 ABS Solid-Wall Plastic Joints and Jointing Materials

Solvent cement for solvent cement joints shall conform to ASTM D 2235. Elastomeric joints shall conform to ASTM D 3212. Gaskets for elastomeric joints shall conform to ASTM F 477.

#### 2.1.6 PVC Plastic Gravity Sewer Piping

##### 2.1.6.1 PVC Plastic Gravity Pipe and Fittings

ASTM D 3034, SDR 35, or ASTM F 949 with ends suitable for elastomeric gasket joints.

##### 2.1.6.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to ASTM D 3212. Gaskets shall conform to ASTM F 477.

#### 2.1.7 PVC Plastic Pressure Pipe and Associated Fittings

##### 2.1.7.1 PVC Plastic Pressure Pipe and Fittings

- a. Pipe and Fittings Less Than 4 inch Diameter: Pipe, couplings and fittings shall be manufactured of materials conforming to ASTM D 1784, Class 12454B.

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785, Schedule 80, with joints meeting requirements of 150

psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified. Fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Push-On Joint: ASTM D 3139, with ASTM F 477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure. Fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467.

- b. Pipe and Fittings 4 inch Diameter to 12 inch: Pipe shall conform to AWWA C900 and shall be plain end or gasket bell end, Pressure Class 150 (DR 18), with cast-iron-pipe-equivalent OD. Fittings shall be gray-iron or ductile-iron conforming to AWWA C110 or AWWA C153 and shall have cement-mortar lining conforming to AWWA C104, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with the PVC plastic pressure pipe specified in this paragraph.

#### 2.1.7.2 PVC Plastic Pressure Joints and Jointing Material

Joints for pipe, 4 inch to 12 inch diameter, shall be push-on joints as specified in ASTM D 3139. Joints between pipe and fittings shall be push-on joints as specified in ASTM D 3139 or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D 3139 and AWWA C111. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F 477. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111, respectively, for push-on joints and mechanical-joints.

#### 2.1.8 High Density Polyethylene Pipe

ASTM F 894, Class 63, size 18 inch through 120 inch. ASTM F 714, size 4 inch through 48 inch. The polyethylene shall be certified by the resin producer as meeting the requirements of ASTM D 3350, cell Class 334433C. The pipe stiffness shall be greater than or equal to  $1170/D$  for cohesionless material pipe trench backfills. Fittings for High Density Polyethylene Pipe: ASTM F 894. Joints for high density polyethylene pipe: Rubber gasket joints shall conform to ASTM C 443.

#### 2.1.9 Reinforced Plastic Mortar Pipe (RPMP)

Reinforced plastic mortar pipe shall be produced by centrifugal casting and shall have an outside diameter equal to ductile iron pipe dimensions from 18 inch to 48 inch. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness shall be 36 psi. RPMP shall be in accordance with ASTM D 3262. Fittings

for RPMP: ASTM D 3840. Joints for RPMP: Bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D 4161 and ASTM F 477.

#### 2.1.10 Reinforced Thermosetting Resin Pipe (RTRP)

RTRP pipe: ASTM D 3262. Fittings for RTRP: ASTM D 3262. Joints for RTRP: Bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F 477.

##### 2.1.10.1 Filament Wound RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 150 psi at 73 degrees F. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

##### 2.1.10.2 Centrifugally Cast RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

#### 2.1.11 Piping Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, piping shall conform to the specifications for pipelines conveying nonflammable substances in AREMA 1-5, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe shall conform to and have strength computed in accordance with ASTM A 746.

## 2.2 CONCRETE MATERIALS

### 2.2.1 Cement Mortar

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

### 2.2.2 Portland Cement

Portland cement shall conform to ASTM C 150, Type II for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking.

### 2.2.3 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94/C 94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 2500 psiminimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.  
Text

## 2.3 MISCELLANEOUS MATERIALS

### 2.3.1 Precast Concrete Manholes and Glass-Fiber-Reinforced Polyester Manholes.

Precast concrete manhole risers, base sections, and tops shall conform to ASTM C 478; base and first riser shall be monolithic.  
Glass-Fiber-Reinforced Polyester Manholes shall conform to ASTM D 3753.

### 2.3.2 Gaskets and Connectors

Gaskets for joints between manhole sections shall conform to ASTM C 443.  
Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C 923 or ASTM C 990.

### 2.3.3 Metal Items

#### 2.3.3.1 Frames, Covers, and Gratings for Manholes

FS A-A-60005, cast iron; figure numbers shall be as indicated:

##### a. Non-traffic manhole:

Frame: Figure 4, Size 22  
Cover: Figure 12, Size 22  
Steps: Figure 19

Frames and covers shall be cast iron, ductile iron or reinforced concrete. Cast iron frames and covers shall be as indicated or shall be of type suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 400 pounds. Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478 or ASTM C 478M. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

#### 2.3.3.2 Manhole Steps

Zinc-coated steel conforming to 29 CFR 1910.27. Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

#### 3.1.1 General Requirements for Installation of Pipelines

Apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

##### 3.1.1.1 Location

The work covered by this section shall terminate at a point approximately 5 feet from the building, unless otherwise indicated. Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 10 feet to a water main or service line. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 10 feet on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet, horizontal distance, to the water line.

- a. Sanitary piping installation parallel with water line:
  - (1) Normal conditions: Sanitary piping or manholes shall be laid at least 10 feet horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.
  - (2) Unusual conditions: When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:
    - (a) The top (crown) of the sanitary piping shall be at least 18 inches below the bottom (invert) of the water main.
    - (b) Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of AWWA-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.
    - (c) The sewer manhole shall be of watertight construction and tested in place.
- b. Installation of sanitary piping crossing a water line:
  - (1) Normal conditions: Lay sanitary piping crossing water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.
  - (2) Unusual conditions: When local conditions prevent a vertical separation described above, use the following construction:
    - (a) Sanitary piping passing over or under water lines shall be constructed of AWWA-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.
    - (b) Sanitary piping passing over water lines shall, in addition, be protected by providing:
      - 1. A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.
      - 2. Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.
      - 3. That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.
- c. Sanitary sewer manholes: No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

#### 3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 02302, "Excavation, Backfilling, and Compacting for Utilities."

#### 3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell ends in the upgrade direction. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose.

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D 2680; saddles for ABS pipe shall comply with Table 3 of ASTM D 2751; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

#### 3.1.1.4 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

#### 3.1.2 Special Requirements

##### 3.1.2.1 Installation of Cast Iron Soil Piping

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations of the pipe manufacturer. Make joints with the rubber gaskets specified for cast iron soil pipe joints and assemble in accordance with the recommendations of the pipe manufacturer.

##### 3.1.2.2 Installation of Concrete Gravity Sewer Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the provisions for rubber gasket jointing and jointing procedures of ACPA 01-103 or of ACPA 01-102, Chapter 9, "Installation, Inspection and Construction Testing." Make joints with the gaskets specified for concrete gravity sewer pipe joints. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets.

Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within one inch of closure, remove the pipe and remake the joint.

##### 3.1.2.3 Installation of Ductile Iron Gravity Sewer Pipe

Unless otherwise specified, install pipe and associated fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation and joint assembly.

- a. Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111.
- b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105, using Class A polyethylene film.

#### 3.1.2.4 Installation of ABS Composite Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations of the plastic pipe manufacturer. Make joints with the primer and solvent cement specified for this joint and assemble in accordance with the recommendations of the pipe manufacturer. Handle solvent cement in accordance with ASTM F 402.

#### 3.1.2.5 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D 2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

#### 3.1.2.6 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section; with the requirements of UBPPA UNI-B-3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

- a. Pipe 4 Inch Diameter Joints: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to fittings, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of UBPPA UNI-B-3 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings in accordance with the requirements of UBPPA UNI-B-3 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of UBPPA UNI-B-3 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly,

and with the recommendations of Appendix A to AWWA C111. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.

- c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C 94 having a minimum compressive strength of 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

### 3.1.3 Concrete Work

Cast-in-place concrete is included in Section 03300N, "Cast-In-Place Concrete."

The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

### 3.1.4 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

### 3.1.5 Miscellaneous Construction and Installation

#### 3.1.5.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

#### 3.1.5.2 Metal Work

- a. Workmanship and finish: Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

### 3.2 FIELD QUALITY CONTROL

#### 3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

#### 3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

##### 3.2.2.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

- a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C 969. Make calculations in accordance with the Appendix to ASTM C 969.
- b. Low-pressure air tests: Perform tests as follows:
  - (1) Concrete pipelines: Test in accordance with ASTM C 924. Allowable pressure drop shall be as given in ASTM C 924. Make calculations in accordance with the Appendix to ASTM C 924.
  - (2) Ductile-iron pipelines: Test in accordance with the applicable requirements of ASTM C 924. Allowable pressure drop shall be as given in ASTM C 924. Make calculations in accordance with the Appendix to ASTM C 924.
  - (3) ABS composite plastic pipelines: Test in accordance with the applicable requirements of UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

(4) PVC plastic pipelines: Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

-- End of Section --

## SECTION 02555

PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM  
12/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105/A 105M	(1998) Carbon Steel Forgings for Piping Applications
ASTM A 106	(1997a) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 234/A 234M	(1997) Piping Fittings of Wrought Carbon Steel for Moderate and High Temperature Service
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM C 518	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM D 1248	(1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1784	(1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and

## Threaded

ASME B31.1 (1998) Power Piping

ASME BPV IX (1998) Boiler and Pressure Vessel Code;  
Section IX, Welding and Brazing  
Qualifications

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook (1995) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-73 (1991; R 1996) Brazing Joints for Copper  
and Copper Alloy Pressure Fittings

## 1.2 SYSTEM DESCRIPTION

The system consists of a buried prefabricated chilled water distribution system including service connections to a point 6 inches inside of the building. The contract drawings show the specific arrangement of piping, sizes and grades of pipe, and other details. The system is designed for an operating pressure of 150 psig and an operating temperature of 45 degrees F for chilled water.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Distribution System; G, AE

Detail drawings consisting of fabrication and assembly drawings, for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents, prior to installation. Detail drawings shall also contain complete piping, wiring and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, method of compensation for pipe expansion and contraction, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation. The drawings shall clearly identify any proposed deviations from the requirements of the contract documents.

## SD-03 Product Data

Distribution System; G, AE

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with the

requirements of the contract documents.

#### SD-07 Certificates

Distribution System; G, AE

The manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification.

Welding; G, AE

Prior to welding operations, a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

#### SD-10 Operation and Maintenance Data

Distribution System; G, RE

Six copies of operation and 6 copies of maintenance manuals for the equipment furnished, 1 complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for equipment startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Manuals shall be approved prior to the field performance testing.

### 1.4 DELIVERY AND STORAGE

After delivery to the jobsite, all materials and equipment shall be protected from anything which could cause damage to the material or equipment. Pipe shall be sealed at each end to keep the interior clean and free of dirt and debris. Fittings shall be kept together and their interior surfaces shall remain clean. Insulation shall be kept dry and clean.

### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.6 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as

a permanent record.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

System components shall be standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The system shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

### 2.2 PIPING AND CASING MATERIALS

#### 2.2.1 General

Metallic pressure pipe, fittings, and piping accessories shall conform to the requirements of ASME B31.1 and shall be types suitable for the temperature and pressure of the water.

#### 2.2.2 Piping

##### 2.2.2.1 Steel Pipe

Piping shall conform to ASTM A 53, Grade B, standard weight, black or to ASTM A 106, Grade B, standard weight.

##### 2.2.2.2 Copper Tubing

Copper tubing shall conform to ASTM B 88, Type K or L.

#### 2.2.3 Casings

##### 2.2.3.1 Polyvinyl Chloride (PVC) Casing

PVC casings shall conform to ASTM D 1784, Class 12454-B with a minimum thickness equal to the greater of 1/100 the diameter of the casing or 60 mils.

##### 2.2.3.2 Polyethylene (PE) Casing

Polyethylene casings shall conform to ASTM D 1248, Type III, Class C, Category 3 or 4, Grade P 34 with thickness as follows:

Casing Diameter (in inches)	Minimum Thickness (in mils)
10 and smaller	125
10 to 18	150
18 through 24	200
over 24	225

##### 2.2.3.3 Reinforced Thermosetting Resin Pipe (RTRP) Casing

RTRP casing shall be of the same material as the pipe, with casing thickness as follows:

Casing Diameter (in inches)	Minimum Thickness (in mils)
8 and smaller	70
10	80
12	105
14	115
16 to 18	120
20	125
24	155

## 2.3 PIPING CONNECTIONS

### 2.3.1 Steel Pipe

Steel pipe smaller than 3/4 inch may be threaded; otherwise, all steel pipe shall be welded. Steel welding fittings shall conform to the requirements of ASTM A 105/A 105M or ASTM A 234/A 234M. Welding fittings shall also conform to ASME B16.9 for butt-weld fittings and ASME B16.11 for socket-weld fittings. Long radius butt-welding elbows conforming to ASME B16.9 shall be used whenever space permits. Pipe Threads shall conform to ASME B1.20.1. Pipe to be threaded shall be schedule 80.

### 2.3.2 Copper Pipe

Copper pipe shall be brazed or connected using an insulated pipe coupling. Wrought copper or cast copper alloy solder joint pressure fittings shall conform to MSS SP-73. Insulated pipe couplings for copper pipe shall be cast bronze containing an O-ring seal on each end and shall be jacketed and sealed to act as an expansion joint.

## 2.4 END SEALS

### 2.4.1 General

Each preinsulated section of piping shall have a complete sealing of the insulation to provide a permanent water and vapor seal at each end of the preinsulated section of piping. Preinsulated sections of piping modified in the field shall be provided with an end seal which is equivalent to the end seals furnished with the preinsulated section of piping. End seals must be tested and certified in accordance with paragraph Casing and End Seal Testing and Certification.

### 2.4.2 Types

End seals provided shall be one of the following types:

- a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Sufficient surface bonding area shall be provided between the casing and the carrier pipe.
- b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. A minimum 1-1/2 inch surface bonding area shall be provided between the cap and both the casing and carrier pipe.
- c. Using elastomer-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.

- d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.
- e. Shrink sleeves.

#### 2.4.3 Casing and End Seal Testing and Certification

Testing and certification procedures by an independent testing laboratory shall demonstrate that casings and end seals are capable of resisting penetration of water into the casing and insulation. The test shall be performed on the type of prefabricated system to be furnished. If more than one type of prefabricated system is to be used, then the tests shall be performed on each type. The test shall consist of hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure. The hot and cold cycle testing shall consist of 14 days of temperature cycling. A fluid with a temperature of 40 degrees F shall circulate through the carrier pipe alternating every 24-hours with a fluid with a temperature of 200 degrees F circulating through the carrier pipe for a low temperature hot water or dual temperature service or 75 degrees F for a chilled water service. While the hot and cold cycle test is being performed, the test sample is either buried or encased in dry bedding sand with a minimum of 12 inches of sand all around the test sample. The carrier pipe size of the test sample shall be 3 inches in diameter and shall be restrained during the test period. The insulation thickness shall not exceed the maximum thickness provided for the piping in the project. Transition time for temperature cycle testing shall not exceed 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Following the hot and cold cycling test, the test sample shall be immersed in a water filled chamber. The pressure on the highest point of the test sample shall not be less than 20 feet of water head pressure subjected over the entire length of the 8 foot test sample of prefabricated pipe. The water shall contain a dye penetrant, which will be used to check for end seal leakage. The pressure in the chamber must be held for not less than 48 hours. Upon completion of this pressure test, the test sample shall be cut open. With the use of a light that will readily show the presence of the dye that was in the water, the test sample shall be inspected. Evidence of the dye inside the test sample shall indicate that the end seal is not acceptable and cannot be certified.

### 2.5 INSULATION

#### 2.5.1 Factory Applied Insulation

Prefabricated pipe and fittings shall be insulated in the factory. Foam insulation for prefabricated insulated pipe and fittings shall be polyurethane foam meeting the requirements of ASTM C 591 having a density not less than 2 pounds per cubic foot (pcf). The polyurethane foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of 0.9 inches. The insulation thermal conductivity factor shall not exceed the numerical value of 0.15 Btu-inch/square foot-degree F-hour at 75 degrees F, when tested in accordance with ASTM C 518. Manufacturer shall certify that the insulated pipe is free of insulation voids.

#### 2.5.2 Field Applied Insulation

Field applied insulation for fittings, and field casing closures, if

required, and other piping system accessories shall be polyurethane matching the pipe insulation. Thickness shall match adjacent piping insulation thickness. Buried fittings and accessories shall have field applied polyurethane insulation to match adjacent piping and shall be protected with a covering matching the pipe casing. Shrink sleeves with a minimum thickness of 50 mils shall be provided over casing connection joints.

## 2.6 CONCRETE VALVE MANHOLES

Concrete valve manholes shall be provided in accordance with Section 02570 VALVE MANHOLES AND PIPING AND EQUIPMENT IN VALVE MANHOLES.

## 2.7 PIPING AND EQUIPMENT IN VALVE MANHOLES

Piping and equipment in valve manholes shall be provided in accordance with Section 02570 VALVE MANHOLES AND PIPING AND EQUIPMENT IN VALVE MANHOLES.

## 2.8 TREATED WATER

A 25 percent concentration by volume of industrial grade propylene glycol shall be provided for the system. Glycol shall be tested in accordance with ASTM D 1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

# PART 3 EXECUTION

## 3.1 INSTALLATION

For all preinsulated, prefabricated systems, the Contractor shall obtain the services of a trained representative of the pipe system manufacturer to instruct the Contractor's work forces in the installation procedures to ensure that the system is installed in accordance with the manufacturer's published instructions and the plans and specifications. The manufacturer's representative shall be a person who regularly performs such duties for the manufacturer. The Contractor shall furnish the Contracting Officer a list of names of personnel trained and certified by the pipe system manufacturer in the installation of this system. Only personnel whose names appear on the list will be allowed to install the system. The list shall not be more than 1 year old.

## 3.2 PIPING SYSTEMS

### 3.2.1 Buried Insulated Systems

Buried insulated systems shall consist of carrier pipe, insulation, casing, end seals, fittings and accessories as specified.

### 3.2.2 Buried Uninsulated Systems

Buried uninsulated systems shall consist of carrier pipe, fittings and accessories as specified.

## 3.3 THRUST BLOCKS

Thrust blocks shall be installed at the locations shown or recommended by

the pipe system manufacturer. Thrust blocks may not be required on all systems, and the need for thrust blocks shall be as recommended by the system manufacturer. Thrust blocks, if necessary, shall be installed at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees. Thrust blocks shall be concrete having a compressive strength of not less than 2000 psi after 28 days and shall be in accordance with Section 03300-CAST-IN-PLACE STRUCTURAL CONCRETE. Thrust blocks shall be placed between solid ground and the fitting to be anchored.

Unless otherwise indicated or directed, the base and the thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Thrust blocks shall be placed so that the joints for all fittings will be accessible for repair wherever possible. No pipe joint shall be embedded in concrete unless the assembly has previously been hydrostatically tested. The thrust blocks shall provide for transfer of thrusts and reactions without exceeding the allowable stress of the concrete and shall be installed in accordance with pipe manufacturer's instructions. In muck or peat, all thrusts shall be resisted by piles or tie rods to solid foundations or by removal of peat or muck which shall be replaced with ballast of sufficient stability to resist thrusts.

### 3.4 INSTALLATION OF PIPING SYSTEMS

The piping system furnished shall be installed in accordance with the piping system manufacturer's instructions. Piping shall be installed without springing or forcing other than what has been calculated for cold spring. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Nonmetallic pipe cut in the field shall be machined to fit couplings or joints and shall be coated or treated to match standard factory coated ends. Copper tubing shall not be installed in the same trench with ferrous piping materials. When nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material, a minimum vertical separation of 12 inches shall be maintained between pipes. Connections between different types of pipe and accessories shall be made with transition fittings approved by the manufacturer of the piping system.

#### 3.4.1 Pitching of Horizontal Piping

Horizontal piping shall be pitched at a grade of not less than 1 inch in 20 feet toward the drain points unless otherwise indicated.

#### 3.4.2 Open Ends

Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

#### 3.4.3 Cutting Prefabricated Piping Sections

Where prefabricated pipe sections are field cut, new end seals similar to the factory applied end seal shall be provided and installed in accordance with the manufacturer's instructions.

#### 3.4.4 Joints

##### 3.4.4.1 Welded Joints

Welded joints between sections of pipe and between pipe and fittings shall be provided where specified or indicated.

#### 3.4.4.2 Threaded Joints

Threaded joints shall not be used belowground. Joints shall be made tight with polytetrafluoroethylene tape applied to the male threads only. Not more than 3 threads shall show after the joint is made up.

#### 3.4.4.3 Brazed Joints

Brazed joints for copper pipe and fittings shall conform to CDA Tube Handbook. Brazing alloys melting above 1100 degrees F shall be utilized.

#### 3.4.5 Expansion Loops

If expansion compensation is needed, expansion loops and expansion bends (Z- and L- type) shall be factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Expansion loops and bends shall be properly designed in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used. Expansion loops and bends shall be shipped to the jobsite in the maximum size sections feasible to minimize the number of field joints. The expansion loops and bends casing and insulation where applicable, shall be suitably sized to accommodate pipe movement. Field joints shall be made in straight runs of the expansion loops and bends, and the number shall be kept to a minimum. For steel pipe, cold springing shall not be allowed when sizing the expansion loops and bends, but piping shall be cold sprung one-half the calculated maximum operational expansion during field assembly. Pipe stress in expansion loops and bends shall conform to the requirements for expansion loops specified in ASME B31.1.

#### 3.4.6 Anchors

Anchor design shall be in accordance with the published data of the manufacturer and for prefabricated systems shall be factory fabricated by the prefabricated system manufacturer. In all cases, the design shall be such that water penetration, condensation, or vapor transmission will not wet the insulation.

#### 3.4.7 Field Casing Closures

Field insulation and encasement of joints shall be accomplished after the visual and pressure tests specified are completed. Field insulation and encasement shall be in accordance with the manufacturer's written instructions. Thickness dimensions of the insulation and casing materials shall not be less than those of the adjoining prefabricated section. Insulating material shall be foamed in place polyurethane. Care should be taken to ensure that field closures are made under conditions of temperature and cleanliness required to produce a sound, continuous vapor barrier. A standard polyethylene heat shrink sleeve shall be installed over the casing and shall have a 6 inch minimum overlap at each end.

#### 3.4.8 Underground Warning Tape

Underground warning tape shall be buried above the piping during the trench backfilling and shall be buried approximately 12 inches deep. Tape shall be [ 0.004 inch thick polyethylene tape] [polyethylene tape with metallic core]. Tape shall be 6 inches wide and be printed with repetitive caution warnings along its length. Tapes shall be yellow in color with black letters. Tape color and lettering shall not be affected by moisture or

other substances contained in the backfill material.

#### 3.4.9 Markers for Underground Piping

Markers for underground piping shall be placed as indicated approximately 2 feet to the right of the distribution system and referenced to the flow direction in the supply line. The marker shall be concrete 6 inch square or round section [2] [3] feet long. The top edge of the marker shall have a minimum 1/2 inch chamfer all around. The letters [CHW] [LHW] [DTW] shall be impressed or cast on the top of the markers to indicate the type of system that is being identified. Each letter shall be formed with a V-shaped groove and shall have a width of stroke at least 1/4 inch at the top and depth of 1/4 inch. The top of the marker shall protrude not more than [1] [2] [3] [4] inches above finished grade.

#### 3.5 EARTHWORK

Earthwork shall be performed in accordance with Section 02316EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

#### 3.6 ELECTRICAL WORK

Electrical work shall be performed in accordance with either Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND or Section 16370ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

#### 3.7 TESTING

Tests shall be conducted before, during, and after installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the Contractor. Test pressure gauges for a specific test shall have dials indicating not less than 1-1/2 times nor more than 2 times the test pressure. It shall be the Contractor's responsibility to make the pipe system workable at his expense.

##### 3.7.1 Metallic Pipe Welds

An approved independent testing firm or firms regularly engaged in radiographic testing shall perform a radiographic examination of the field welds. The radiographic testing shall be performed in accordance with ASME B31.1. All radiographs shall be reviewed and interpreted by a Certified Level III Radiographer employed by the testing firm. Any welds found to be unacceptable shall be removed, rewelded and radiographically reexamined in accordance with the above criteria. Such repair and reexamination shall be accomplished at no cost to the Government.

##### 3.7.2 Carrier Pipe Cleaning and Testing

Distribution piping shall be tested as required before backfilling and with all joints exposed. The area between joints may be backfilled as necessary to prevent pipe movement.

###### 3.7.2.1 Cleaning Carrier Pipe

Prior to testing, the interior of the carrier pipe shall be cleaned of foreign materials by thorough flushing with clean water. Water shall be circulated at a velocity between 2 and 3 m/s (7 and 10 feet per second) for a minimum of 4 hours. If required, temporary and/or supplementary pumps shall be provided to ensure that required velocity is achieved. System

strainers shall be cleaned after the flushing operation is complete. Temporary strainers shall be installed as required. After flushing, the water shall remain in the piping system for testing of the system. All air shall be removed from the system prior to starting the tests.

#### 3.7.2.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure cycling shall have 4 cycles. Each cycle shall consist of a 10 minute period at 150 psig followed by a 5 minute period at a pressure less than 50 psig. The next cycle shall begin immediately following the completion of the previous cycle. Pressure rise and drop shall not exceed 100 psi per minute. The pressure gauge shall be located and the pressure measured at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling, the first hydrostatic pressure test shall be performed. During the first hydrostatic pressure test, the system shall be proven tight at a pressure of 1-1/2 times the working pressure up to 150 psig. This pressure shall be held for a minimum of 1 hour. The method of pressurizing the system shall be disconnected from the system before starting the 1 hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of pressure loss shall be determined, corrected and the hydrostatic pressure cycling and first hydrostatic pressure test shall be repeated until the system can hold the required pressure for at least 1 hour. After successful completion of the first hydrostatic pressure test, the water shall be drained out of the piping system and the piping system filled with treated water as defined in paragraph TREATED WATER for the remaining tests and for permanent operation of the system. The hydrostatic pressure cycling and tests shall be repeated after the system has been filled with treated water, using the same test conditions and criteria.

#### 3.7.2.3 Operational Test

Operational test shall be performed on the complete system or testable portions thereof. The test shall be conducted with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test will have two cycles. Each cycle shall consist of a 6-hour period with treated water in the system at the maximum operating temperature of 85 degrees F and maximum flow rate, and a period of at least 6-hours with no flow. The Contractor shall supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Water shall be circulated through supply lines and returned through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe and to show that obstructions do not exist in the piping system. Any unusual indicated pressure drop will be investigated and any obstructions removed. Any leaks found shall be repaired. After any obstructions have been removed and any leaks repaired, the operational test shall be repeated until successfully passed.

#### 3.7.2.4 Final Hydrostatic Test

After successful completion of the operational test, the system shall be pressurized to 1-1/2 times the working pressure up to 150 psig. This pressure shall be held for a minimum of 4 hours. Means of pressurizing shall be disconnected prior to the start of the 4-hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of the pressure loss shall be determined, corrected, and all of the hydrostatic pressure cycling and tests repeated.

-- End of Section --

## SECTION 02630A

STORM-DRAINAGE SYSTEM  
03/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 198 (1998) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48 (1994a) Gray Iron Castings

ASTM A 123/A 123M (1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 536 (1999el) Ductile Iron Castings

ASTM A 929/A 929M (1997) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

ASTM B 26/B 26M (1998) Aluminum-Alloy Sand Castings

ASTM C 32 (1999el) Sewer and Manhole Brick (Made from Clay or Shale)

ASTM C 55 (1999) Concrete Brick

ASTM C 62 (1997a) Building Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C 76 (1999) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C 139 (1999) Concrete Masonry Units for Construction of Catch Basins and Manholes

ASTM C 231 (1997el) Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 270 (1997) Mortar for Unit Masonry

ASTM C 443 (1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets

ASTM C 478 (1997) Precast Reinforced Concrete Manhole Sections

ASTM C 507 (1999) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

ASTM C 789 (1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

ASTM C 828 (1998) Low-Pressure Air Test of Vitrified Clay Pipe Lines

ASTM C 850 (1998) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Ft. of Cover Subjected to Highway Loadings

ASTM C 877 (1994) External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C 924 (1998) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

ASTM C 1103 (1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

ASTM D 1056 (1998) Flexible Cellular Materials - Sponge or Expanded Rubber

ASTM D 1171 (1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)

ASTM D 1557 (1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))

ASTM D 1751 (1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (1984; R 1996e1) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 1784 (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D 2167 (1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2321 (1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 794	(1999) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 949	(1999) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F 1417	(1992; R 1998) Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-03 Product Data

#### Placing Pipe;

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

### SD-04 Samples

#### Pipe for Culverts and Storm Drains;

### SD-07 Certificates

Resin Certification;  
Pipeline Testing;  
Determination of Density;  
Frame and Cover for Gratings;

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

### 1.3 DELIVERY, STORAGE, AND HANDLING

#### 1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

#### 1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

## PART 2 PRODUCTS

### 2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

#### 2.1.1 Concrete Pipe

ASTM C 76, Class III.

##### 2.1.1.1 Reinforced Elliptical Culvert and Storm Drainpipe

ASTM C 507. Horizontal elliptical pipe shall be Class HE-III.

#### 2.1.2 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

##### 2.1.2.1 Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

##### 2.1.2.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

##### 2.1.2.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

#### 2.1.2.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

### 2.2 DRAINAGE STRUCTURES

#### 2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

#### 2.2.2 Precast Reinforced Concrete Box

For highway loadings with 2 feet of cover or more or subjected to dead load only, ASTM C 789; for less than 2 feet of cover subjected to highway loading, ASTM C 850.

### 2.3 MISCELLANEOUS MATERIALS

#### 2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 4,000 psi concrete under Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

#### 2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 5 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

#### 2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

#### 2.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

#### 2.3.5 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure or made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

#### 2.3.6 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

#### 2.3.7 Joints

##### 2.3.7.1 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

##### 2.3.7.2 Flexible Watertight, Gasketed Joints

- a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.
- b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

### 2.3.7.3 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

### 2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

## PART 3 EXECUTION

### 3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems" and the requirements specified below.

#### 3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 6 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary.

Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

#### 3.1.2 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

### 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

#### 3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe

or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

### 3.2.2 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

### 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

#### 3.3.1 Concrete, Clay, PVC, and Ribbed PVC

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

### 3.4 JOINTING

#### 3.4.1 Concrete and Clay Pipe

##### 3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently

stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

#### 3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

#### 3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

- a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.
- b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.
- c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

#### 3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

#### 3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

#### 3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

### 3.5 DRAINAGE STRUCTURES

#### 3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, precast reinforced concrete, complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

### 3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide

at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

### 3.7 BACKFILLING

#### 3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

#### 3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

#### 3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

#### 3.7.4 Compaction

##### 3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

##### 3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

### 3.7.5 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

### 3.8 PIPELINE TESTING

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C 828. Low pressure air testing for concrete pipes shall conform to ASTM C 924. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 or ASTM C 924, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the

top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

-- End of Section --

## SECTION 02741N

## BITUMINOUS CONCRETE PAVEMENT

**09/99**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 698	(1991) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft (600 kN-m/m))
ASTM D 1188	(1996) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2726	(1996; Rev. A) Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

## VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT)

VDOT RBS	(2002) Road and Bridge Specifications
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## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-05 Design Data

Job-mix formula;

SD-07 Certificates

Stone Base Course;

Paint;

## 1.3 QUALITY ASSURANCE

## 1.3.1 Modification to References

Except as specified herein or as indicated, work and materials shall be in accordance with the VDOT RBS. The provisions therein for method of measurement and payment do not apply, and references to "Engineer" and "State" shall be interpreted to mean the "Contracting Officer" and the "Federal Government" respectively.

### 1.3.2 Job-Mix Formula

Submit the mix design, including mixing temperature, for approval. The mix design shall include a certified laboratory analysis of mix composition with marshall stability value, void content, and flow. After mix design approval, job mixes shall conform to the range of tolerances specified in VDOT RBS. An identical mix design previously approved within the past 12 months by the Resident Contracting Officer, may be used without further approval, provided that copies of the previous approval are submitted. Obtain acknowledgement of receipt prior to bituminous concrete placement. Submit additional data regarding materials if the source of the materials changes.

### 1.4 ENVIRONMENTAL REQUIREMENTS

Do not produce or place bituminous concrete when the weather is rainy or foggy, when the base course is frozen or has excess moisture, or when the ambient temperature is less than 40 degrees F in the shade away from artificial heat.

### 1.5 BARRICADES AND SIGNALS

Provide and maintain temporary signs, signals, lighting devices, markings, barricades, and channelizing and hand signaling devices to protect personnel and new construction from damage by equipment and vehicles until the surface is approved by the Contracting Officer.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Bituminous Concrete Mix

VDOT RBS, Section 211, Type SM-9, BM 37.5 for material and mix. Provide crushed stone aggregates for the bituminous mix.

##### 2.1.1.1 Recycled Asphalt Material

Bituminous concrete mix may contain a maximum of 25 percent by weight of the total aggregate material, reclaimed asphalt pavement (RAP). Mix design shall meet the requirements for the type of bituminous concrete specified. Clearly state the viscosity of reclaimed asphalt cement, grade of new asphalt cement, properties of recycling agent if used, and percentage of each in the mix. Combine asphalts and recycling agents to achieve a viscosity of 2000 plus or minus 400 poises at 140 degrees F. Furnish a new job mix formula for each change in percentage of RAP material used.

#### 2.1.2 Stone Base Course

VDOT RBS, Section 208, Size No. 21A, 21B, or 22.

#### 2.1.3 Bituminous Tack Coat

VDOT RBS, Section 310. Emulsified asphalts shall be diluted at the rate of one part water to one part asphalt.

#### 2.1.4 Paint

VDOT RBS, Section 704, white.

#### 2.2 MIX PLANT

VDOT RBS, Section 211.12.

### PART 3 EXECUTION

#### 3.1 INSTALLATION AND APPLICATION

Provide a stone base course, and a bituminous concrete surface course. Subgrade preparation shall be as specified in Section 02300A, "Earthwork."

##### 3.1.1 Stone Base Course Placement

Begin spreading base material at the point nearest the source of supply. Permit traffic and hauling over the base. Fill ruts formed by traffic and reroll. After base course placement, continue machining and rolling until surface is smooth, compacted, well bonded, and true to the designed cross section. Compact to 100 percent ASTM D 698 maximum dry density. Maintain the base smooth and true to grade and cross section until bituminous concrete placement.

##### 3.1.2 Bituminous Tack Coat Placement

Provide tack coat on existing pavement to be overlaid at the rate of 0.10 gallon residual asphalt per square yard. Thoroughly clean surfaces to receive the tack coat immediately prior to application of tack coat. Tack coat shall be tacky at the time of bituminous concrete placement.

##### 3.1.3 Bituminous Concrete Application

###### 3.1.3.1 Placing Temperature

Minimum temperature of bituminous concrete during placement into mechanical spreader shall be 225 degrees F. Mixtures which have a lower temperature shall be rejected.

###### 3.1.3.2 Joints

Where new pavement abuts existing bituminous pavement, cut existing surface course along straight lines approximately 6 inches from edge. Cuts shall be vertical and extend the full depth of the surface course. Prior to bituminous concrete placement, apply asphalt cement to exposed edges of cold joints.

###### 3.1.3.3 Spreading and Finishing Equipment

Spread the bituminous concrete to a uniform density and produce a smooth finish, true to cross section and free from irregularities. Provide adjustable screeds to shape the surface to true cross section.

###### 3.1.3.4 Bituminous Concrete Placement

As continuous as possible. Place in maximum 2 inch lifts. Avoid passing rollers over unprotected edges of bituminous concrete prior to bituminous concrete cooling. If rollers pass over unprotected edges of bituminous concrete prior to cooling, cut bituminous concrete back to expose full depth of bituminous concrete. Immediately prior to resumption of bituminous concrete placement, coat exposed edges of bituminous concrete with asphalt cement. When bituminous concrete placement resumes, rake the hot bituminous concrete against asphalt cement and compact.

#### 3.1.3.5 Featheredges

Accomplish featheredging by raking out the larger aggregate as necessary and sloping the pavement uniformly throughout the featheredge to create a smooth transition. Unless indicated otherwise, featheredge transition shall be 10 feet.

#### 3.1.3.6 Compaction

VDOT RBS for equipment and compaction procedures, modified to compact bituminous concrete to 96 percent of maximum laboratory density. Finished surface shall be uniform in texture and appearance and free of cracks and creases.

#### 3.1.3.7 Protection

No vehicular traffic shall be allowed on pavement for a minimum of 6 hours after final rolling, or until bituminous concrete has cured, whichever is longer.

### 3.2 PAVEMENT MARKINGS

Unless indicated otherwise, provide painted lines 4 inches in width. Apply paint after bituminous concrete has cured for a minimum of 7 days, and minimum ambient temperature is 40 degrees F. Apply paint to clean, dry surfaces, and protect surfaces from traffic until dry. Provide uniform paint film of sufficient thickness to completely conceal pavement.

### 3.3 FIELD QUALITY CONTROL

#### 3.3.1 Sampling

Provide new materials where samples are taken. Take the number and size of samples required to perform the following tests.

##### 3.3.1.1 Bituminous Concrete Sampling

- a. Job Mix: Take one initial sample and one sample for every 400 tons or fraction thereof.
- b. Thickness: Take one sample for every 500 square yards or fraction thereof.
- c. Density: One field test for every 1000 square yards or fraction thereof, and one laboratory test for the project. Provide minimum 4 inch diameter cores if nuclear testing is not used.

##### 3.3.1.2 Stone Base Course Sampling

- a. Thickness: Take one sample for every 500 square yards or fraction thereof.
- b. Density: One field test for every 1000 square yards or fraction thereof, and one laboratory test for the project.

### 3.3.2 Testing

Provide for each sample.

#### 3.3.2.1 Bituminous Concrete Testing

- a. Job Mix: Determine gradation and bitumen content.
- b. Thickness: Maximum allowable deficiency shall be 1/4 inch less than the indicated thickness. Average thickness shall be as indicated.
- c. Density, In Place: ASTM D 2922 and ASTM D 3017; cored sample ASTM D 1188 or ASTM D 2726.

#### 3.3.2.2 Stone Base Course Testing

- a. Thickness: Maximum allowable deficiency shall be 1/2 inch less than the indicated thickness. Average thickness shall be as indicated.
- b. Density: ASTM D 1556 or ASTM D 2922 and ASTM D 3017.

-- End of Section --

## SECTION 02763A

## PAVEMENT MARKINGS

04/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 247 (1981; R 1996) Glass Beads Used in Traffic  
Paint

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792 (1998) Density and Specific Gravity  
(Relative Density) of Plastics by  
Displacement

ASTM E 28 (1999) Softening Point of Resins by Ring  
and Ball Apparatus

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325 (Rev C; Notice 1; Canc. Notice 2) Beads  
(Glass Spheres) Retro-Reflective (Metric)

FS TT-P-1952 (Rev D; Canc. Notice 1) Paint, Traffic and  
Airfield Marking, Waterborne (Metric)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Paint;

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

## 1.3 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch

number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

#### 1.4 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

##### 1.4.1 Thermoplastic Application Equipment

###### 1.4.1.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

###### 1.4.1.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

###### 1.4.1.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

a. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 375 degrees F, at widths varying from 3 to 12 inches and in thicknesses varying from 0.020 to 0.190 inch and shall

have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.

b. Portable Application Equipment: The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 375 to 425 degrees F, of extruding a line of 3 to 12 inches in width, and in thicknesses of not less than 0.125 inch nor more than 0.190 inch and of generally uniform cross section.

#### 1.4.2 Surface Preparation Equipment

##### 1.4.2.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

##### 1.4.2.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

#### 1.4.3 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

##### 1.4.3.1 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

#### 1.4.4 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

### 1.5 HAND-OPERATED, PUSH-TYPE MACHINES

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

### 1.6 MAINTENANCE OF TRAFFIC

#### 1.6.1 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

### 1.7 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

## PART 2 PRODUCTS

### 2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for airfields, roads, and streets shall conform to FS TT-P-1952, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

### 2.2 THERMOPLASTIC COMPOUNDS

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

#### 2.2.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

Component	Percent by Weight	
	White	Yellow
Binder	17 min.	17 min.
Titanium dioxide	10 min.	-
Glass beads,	20 min.	20 min.
Calcium carbonate & inert fillers	49 max.	*
Yellow pigments	-	*

\*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

#### 2.2.2 Physical Properties

##### 2.2.2.1 Color

The color shall be as indicated.

##### 2.2.2.2 Drying Time

When installed at 70 degrees F and in thicknesses between 1/8 and 3/16 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

##### 2.2.2.3 Softening Point

The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

##### 2.2.2.4 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

#### 2.2.3 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic compound (VOC). Solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

#### 2.3 REFLECTIVE MEDIA

Reflective media for airfields shall conform to FS TT-B-1325, Type I, Gradation A. Reflective media for roads and streets shall conform to FS TT-B-1325, Type I, Gradation A or AASHTO M 247, Type I.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be re-cleaned, when work has been stopped due to rain.

#### 3.1.1 Pretreatment for Early Painting

Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.

#### 3.1.2 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

#### 3.1.3 Cleaning Concrete Curing Compounds

On new Portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

- a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.
- b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.
- c. All remaining curing compound is intact; all loose and flaking

material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

### 3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

#### 3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint.

Paint shall be applied pneumatically with approved equipment at rate of coverage specified. The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

##### 3.2.1.1 Rate of Application

a. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon.

##### 3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

#### 3.2.2 Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint.

##### 3.2.2.1 Primer

After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the thermoplastic composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the thermoplastic manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

a. Asphalt Concrete Primer: Primer shall be applied to all asphalt

concrete pavements at a wet film thickness of 0.005 inch, plus or minus 0.001 inch (265-400 square feet per gallon).

### 3.2.2.2 Markings

After the primer has "set-up", the thermoplastic shall be applied at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Immediately after installation of the marking, drop-on glass spheres shall be mechanically applied so that the spheres are held by and imbedded in the surface of the molten material.

a. Extruded Markings: All extruded thermoplastic markings shall be applied at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch.

b. Sprayed Markings: All sprayed thermoplastic markings shall be applied at the specified width and the thicknesses designated in the contract plans. If the plans do not specify a thickness, centerline markings shall be applied at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

c. Reflective Glass Spheres: Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 1 pound per 20 square feet of compound.

## 3.3 MARKING REMOVAL

Pavement marking, including plastic tape, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Contractor shall demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

### 3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

### 3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Cleanup shall immediately follow removal operations in areas subject to air traffic. Debris shall be disposed of at approved sites.

-- End of Section --

## SECTION 02770A

SITE CONCRETE  
03/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 182 (1991) Burlap Cloth Made from Jute or Kenaf

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185 (1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM C 31/C 31M (1996) Making and Curing Concrete Test Specimens in the Field

ASTM C 143 (1990a) Slump of Hydraulic Cement Concrete

ASTM C 171 (1997) Sheet Materials for Curing Concrete

ASTM C 172 (1997) Sampling Freshly Mixed Concrete

ASTM C 173 (1996) Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 231 (1997) Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 309 (1997) Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 920 (1995) Elastomeric Joint Sealants

ASTM D 1751 (1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 3405 (1996) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

##### Concrete;

Copies of certified delivery tickets for all concrete used in the construction.

#### SD-06 Test Reports

##### Field Quality Control;

Copies of all test reports within 24 hours of completion of the test.

### 1.3 WEATHER LIMITATIONS

#### 1.3.1 Placing During Cold Weather

Concrete placement shall not take place when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing.

Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

#### 1.3.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

### 1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

#### 1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness

requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

#### 1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

### PART 2 PRODUCTS

#### 2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 3500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches. All exposed site concrete shall be integrally colored, Best "Miami Buff".

##### 2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

##### 2.1.2 Slump

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C 143.

##### 2.1.3 Reinforcement Steel

Wire mesh reinforcement shall conform to ASTM A 185.

#### 2.2 CONCRETE CURING MATERIALS

##### 2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

##### 2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

##### 2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

#### 2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used,

except that emulsified mixtures are not acceptable.

## 2.4 JOINT FILLER STRIPS

### 2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

### 2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 3/8 inch thick, unless otherwise indicated.

## 2.5 JOINT SEALANTS

### 2.5.1 Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to ASTM C 920.

### 2.5.2 Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to ASTM D 3405.

## 2.6 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

### 2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

### 2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of

inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

### PART 3 EXECUTION

#### 3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement as directed.

##### 3.1.1 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

#### 3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

##### 3.2.1 Sidewalks, Site Concrete

Forms for sidewalks and site concrete shall be set with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

##### 3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

#### 3.3 CONCRETE PLACEMENT AND FINISHING

##### 3.3.1 Formed Concrete

Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The

concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

### 3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

### 3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

### 3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

## 3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

### 3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

### 3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

### 3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

### 3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

### 3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

### 3.5 CONCRETE JOINTS

Concrete joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

#### 3.5.1 Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

#### 3.5.2 Expansion Joints

Expansion joints shall be formed with 3/8 inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

#### 3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

### 3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

### 3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length. Contraction joints shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

### 3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 3/8 inch in width shall be provided at intervals not exceeding 20 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

## 3.7 CURING AND PROTECTION

### 3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

#### 3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

#### 3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to

be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

### 3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

### 3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

### 3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

### 3.7.4 Protective Coating

Protective coating of linseed oil mixture shall be applied to the exposed-to-view concrete surface.

#### 3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards per gallon for first application and not more than 70 square yards per gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

#### 3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

### 3.8 FIELD QUALITY CONTROL

#### 3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing.

Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

#### 3.8.2 Concrete Testing

##### 3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

##### 3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231.

ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on

randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector.

If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

#### 3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

#### 3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine.

If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

#### 3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

### 3.9 SURFACE DEFICIENCIES AND CORRECTIONS

#### 3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

#### 3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch.

Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

#### 3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

## SECTION 02821A

FENCING  
02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 121	(1999) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 585	(1997) Aluminum-Coated Steel Barbed Wire
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2000e2) Ready-Mixed Concrete
ASTM F 1043	(2000) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 626	(1996a) Fence Fittings
ASTM F 668	(1999a) Poly(Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence

Statement, signed by an official authorized to certify on behalf

of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

### 1.3 APPROVAL OF POLYVINYL CHLORIDE-COATED FENCE MATERIALS

Polyvinyl chloride-coated fence materials shall be thoroughly inspected for cracking, peeling, and conformance with the specifications by the Contracting Officer's Representative prior to installation. Any fence materials rejected by the Contracting Officer's Representative shall be replaced by the contractor with approved materials at no additional cost to the Government.

## PART 2 PRODUCTS

### 2.1 FENCE FABRIC

Fence fabric shall conform to the following:

#### 2.1.1 Chain Link Fence Fabric

Class 2b polyvinyl chloride-coated steel fabric with 0.3 ounces of zinc coating per square foot in accordance with ASTM F 668. Fabric shall be fabricated of 9 gauge wire woven in 2 inch mesh. Polyvinyl chloride coating for fabric and all other fence components shall be manufacturer's standard brown in color. Fabric height shall be 6 feet. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

### 2.2 POSTS

#### 2.2.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II, roll-formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Post shall be either Group IA steel pipe, Group IC, Group II, roll-formed steel sections, or Group III steel H-sections and shall be zinc coated (Type A) and polyvinyl chloride coated conforming to the requirements of ASTM F 1043. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence.

### 2.3 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Braces and rails shall be Group IA, steel pipe, size NPS 1-1/4 or Group II, formed steel sections, size 1-21/32 inch and shall be zinc coated (Type A) and polyvinyl chloride-coated conforming to the requirements of ASTM F 1043. Group II, formed steel sections, size 1-21/32 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

### 2.4 WIRE

#### 2.4.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

## 2.5 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Ferrous accessories shall also be polyvinyl chloride-coated, minimum thickness of 0.006 inch, maximum thickness of 0.015 inch. Color coating of fittings shall match the color coating of the fabric. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified. Threaded hardware shall be painted to match polyvinyl chloride coatings.

## 2.6 CONCRETE

ASTM C 94/C 94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## 2.7 SLATS

Fencing slats to be extruded high-density virgin polyethylene, containing brown color pigmentation and U.V. inhibitors. Slats are to be flat, tubular shape 5/16" in depth and minimum 0.02" thick, width to match fencing material.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

## 3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 2 inch clearance between the bottom of the fabric and finish grade.

## 3.3 POST INSTALLATION

### 3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is

covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground; post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

### 3.4 RAILS

#### 3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

### 3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 12 foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

### 3.6 TENSION WIRES

Tension wires shall be installed along the bottom of the fence line and attached to the terminal posts of each stretch of the fence. Bottom tension wire shall be installed within the bottom 6 inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

### 3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at

approximately 15 inch intervals and fastened to all rails and tension wires at approximately 24 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 2 plus or minus 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of not more than 2-1/2 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and retested at the Contractor's expense.

### 3.8 SLATS

Slats shall be installed in a vertical direction.

-- End of Section --

## SECTION 02840A

ACTIVE VEHICLE BARRIERS  
02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 106 (1999e1) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM D 3034 (1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)

## SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 517 (1998) Hydraulic Hose

## UNDERWRITERS LABORATORIES (UL)

UL 486A (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors

## 1.2 GENERAL REQUIREMENTS

Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

## 1.3 NAMEPLATES

Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:

- a. Manufacturer's name.
- b. Model number.
- c. Serial number.
- d. Date of manufacture.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Installation; G, AE

Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. Detail drawings shall include a copy of the crash test report or certificate of barrier performance.

##### SD-03 Product Data

Vehicle Barriers; G, AE  
Spare Parts; G

A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.

##### SD-06 Test Reports

Field Testing; G, AE

Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

##### SD-10 Operation and Maintenance Data

Vehicle Barriers; G, AE  
Operating and Maintenance Instructions; G, AE

Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F to 150 degrees F to cover winter operation, summer operation, and ambient temperature ranges in between.

#### 1.5 DELIVERY AND STORAGE

Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

#### 1.6 SPARE PARTS

A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

### PART 2 PRODUCTS

#### 2.1 VEHICLE BARRIER - CRASH BEAM

The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 168 inches. The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound vehicle traveling at 30 miles per hour, with maximum beam deflection of 20 feet.

##### 2.1.1 Powered Crash Beam

The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.

##### 2.1.1.1 Failure Mode of Operation

A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.

#### 2.1.1.2 Hydraulic Power Unit

The hydraulic power unit shall contain conventional hydraulic fluid which maintains its viscosity between 80 and 4000 saybolt universal seconds (SUS) even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F. A hydraulic fluid heater shall be provided so that the viscosity remains between 80 and 4000 SUS for ambient temperatures below 20 degrees F. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressure shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

- a. Flexible hydraulic lines shall be in accordance with SAE J 517.
- b. Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

#### 2.1.1.3 Hydraulic Power Unit Enclosure

A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

### 2.2 ELECTRICAL WORK

Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Sections 16415A ELECTRICAL WORK, INTERIOR and 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

### 2.3 CONTROL PANEL

A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding gate limit switches. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run

to terminal strips.

### 2.3.1 Voltage

The control circuit shall operate from a 120 volt 60 Hz supply. The control circuit voltage shall be 24 ac for all external control panels.

### 2.3.2 Main Control Panel

A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier.

An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.

### 2.3.3 Remote Control Panel

A remote control panel shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

## 2.4 MISCELLANEOUS EQUIPMENT

### 2.4.1 Heater

A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F. For retractable bollards, a 250-watt heater shall be provided for each bollard.

### 2.4.2 Vertical Arm Gates (Traffic Arms)

Vertical arm gates shall have an opening and closing time of less than or equal to 15 seconds. The gates shall be capable of 15 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each gate shall be capable of being operated from a remote open-close push button station. Gates shall have a hand-crank mechanism which will allow manual operation during power failures. Each gate shall be supplied with a handcrank. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction

is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.

## 2.5 FINISH

Surfaces shall be painted in accordance with requirements of Section 09900 PAINTS AND COATINGS except for materials supplied with manufacturer's standard finish. The barrier crash gate shall be painted white and the crash beam shall be painted reflective yellow with 3 inch wide black diagonal stripes.

## 2.6 CONCRETE

The concrete shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

## 2.7 WELDING

Welding shall be in accordance with AWS D1.1.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Installation shall be in accordance with manufacturers instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

## 3.2 HYDRAULIC LINES

Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

## 3.3 ELECTRICAL

All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

## 3.4 FIELD TESTING

Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. The Contracting Officer shall be notified at least 7 days prior to the beginning of the

field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Contracting Officer. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Government. Adjustments and repairs shall be done by the Contractor under the direction of the Contracting Officer. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

### 3.5 FIELD TRAINING

A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

-- End of Section --

## SECTION 02915A

TRANSPLANTING EXTERIOR PLANT MATERIAL  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1 (1996) Nursery Stock

## 1.2 SUBMITTALS

Instruction for care of installed plant material during initial establishment period and long term care (trees and shrubs only).

All plantings, excluding nature trees, currently located around existing Building 18 shall be dug by the landscape contractor prior to any other site disturbance. The root balls for dug trees and shrubs shall be secured, per industry standards, with burlap. The dug plants shall be placed in the shade and watered as needed to ensure the root balls remain damp. They shall then be transported to a designated area at Langley AFB (see Ms. Patsy Kerr @ 757-764-1090 for designated area location). The plants shall then be heeled in at that location, using recycled mulch as needed. The plants shall be thoroughly watered after heeling in and then left to be maintained by Langley AFB. Contact Patsy Kerr as soon as the heeling-in procedure has begun and when it is completed.

## 1.3 PLANT MATERIAL SURVIVABILITY

Plant material survivability shall be determined by growing condition; root pruning and transplanting method to maintain a healthy root system; and recovery of leaves or needles with the crown in good balance with the trunk free from disfigurement or abrasion.

## 1.4 DECIDUOUS TREES

A "P1" height to caliper relationship shall be maintained in accordance with ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

## 1.4.1 Single stem

The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader. The form of growth desired shall be as indicated.

## 1.4.1.1 Multi-stem

All countable stems, in aggregate, shall be maintained. To be considered a stem, there shall be no division of the trunk which branches a minimum 6 inches from the ground surface. The form of growth desired shall be as indicated.

#### 1.4.1.2 Specimen

The tree shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

#### 1.4.2 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA Z60.1. Plant material shall bear a relationship to the size and species of plant with the crown in good balance with the trunk, well shaped, and with sufficient well-spaced side branches. The form of growth desired shall be as indicated.

#### 1.4.3 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANLA Z60.1. Plant material shall bear a relationship to the size and species of plant with the crown in good balance with the trunk, well shaped, and with sufficient well-spaced side branches. The form of growth desired shall be as indicated.

#### 1.4.4 Protection During Transplanting

Plant material shall be protected during transplanting to prevent desiccation and damage to the branches, trunk, and root system. Branches shall be protected by tying-in. Exposed branches shall be covered during transport. Plant material shall be undamaged, well shaped, vigorous and healthy with a well-branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after heeling in. Plant material showing desiccation, abrasion, sun scald injury or structural branching damage shall be replaced at no cost to the government.

#### 1.5 STORAGE OF MATERIALS

Storage of material shall be in designated areas.

#### 1.6 HANDLING OF MATERIALS

Materials shall not be dropped from vehicles. Plant material shall be transported without scarring trunks or deforming crown branching. Materials found to be in unacceptable condition shall be replaced at no additional cost to the Government.

#### 1.7 TIME LIMITATION

The time limitation from digging, removing, transporting, to heeling in transplanted plant material shall be the same day. The time limitation between installing the plant material and placing the mulch shall be a maximum 48 hours.

#### 1.8 WARRANTY

Transplanted plant material shall require no warranty for survivability.

## PART 2 PRODUCTS

### 2.1 MULCH

Mulch shall be free from deleterious materials. Mulch materials shall be native to the region.

#### 2.1.1 Organic Mulch

##### 2.1.1.1 Recycled Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 x 2-1/2 inch screen. It shall be cleaned of all sticks a minimum 1 inch in diameter and plastic materials a minimum 3 inch length. The material shall be treated to retard the growth of mold and fungi. Other recycled mulch may include peanut shells, pecan shells or cocoa bean shells.

### 2.2 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall be potable or supplied by an existing irrigation system.

## PART 3 EXECUTION

### 3.1 TRANSPLANTED PLANT MATERIAL TIME AND CONDITIONS

#### 3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be transplanted from 10-1 to 4-15.

#### 3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be transplanted from 10-1 to 4-15.

#### 3.1.3 Transplanting Conditions

All transplanting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to all transplanting operations, proposed transplanting times shall be submitted for approval.

#### 3.1.4 Underground Utilities

The location of underground utilities and facilities at both the removal and installing sites shall be verified and marked. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

#### 3.1.5 Protecting Existing Vegetation

When there are established lawns at the heeling-in sites, the turf shall be covered and/or protected during the operation. Existing trees, shrubs, and plant beds at the heeling-in site that are to be preserved shall be barricaded along the dripline. The area shall be barricaded and protected

from damage by a tree barricade or other measure. Damage to existing plant material shall be mitigated by the Contractor at no additional cost to the Government. Damage shall be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.1.6 Plant Material Preparation and Handling

3.1.6.1 Plant Material Preparation

Plant material designated for transplanting shall be watered thoroughly several days before root pruning, digging or moving. Broken or interfering growth shall be pruned. Large canopy and specimen plant material shall be wire balled and burlapped. Trees shall be lifted by the use of tree straps. Canopy and evergreen trees up to a maximum 12 inches caliper shall be transplanted by the largest available tree spade in order to reduce shock. The installing site for the plant material shall be prepared and excavated in accordance with paragraphs: Transplanting Plant Material Time and Conditions, Installing Site Preparation, and Installing Site Excavation, prior to moving the plant material.

3.1.6.2 Tree Spading

The following minimum size spades shall be used for trees sized as measured at caliper; 6 inches above the ground for trees 4 inches in diameter or smaller, 12 inches above the ground for trees with a larger diameter.

Tree Spade Size	Deciduous Tree	Evergreen Tree
Minimum 44 inch	Minimum 2 inch to Maximum 3 inch caliper	Minimum 5 feet to Maximum 7 feet height
Minimum 66 inch	Minimum 3 inch to Maximum 5 inch caliper	Minimum 7 feet to Maximum 10 feet height
Minimum 85 inch	Minimum 6 inch to Maximum 8 inch caliper	Minimum 12 feet to Maximum 15 feet height

3.1.6.3 Caliper

The caliper shall be measured at a minimum 6 inch height above the ground surface for trees up to a maximum 4 inch caliper. The caliper shall be measured at a minimum 12 inch height above the ground surface for trees with a larger caliper.

3.2 FINISHING

3.2.1 Placing Mulch

The placement of mulch shall occur a maximum of 24 hours after transplanting to heeling-in site. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the root balls with a minimum 2 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.3 RESTORATION AND CLEAN UP

### 3.3.1 Restoration

Turf areas containing ruts or dead turf, as a result of work under this contract, shall be graded smooth and sodded with the same species. All pavements and facilities that have been damaged from the heeling-in operation shall be restored to original condition at the Contractor's expense.

## 3.4 PLANT ESTABLISHMENT PERIOD

### 3.4.1 Acceptable Plant Material

Plant material shall be undamaged, well shaped, vigorous and healthy with a well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after heeling-in and in accordance with paragraph PLANT MATERIAL SURVIVABILITY. Plant material showing desiccation, abrasion, sun-scald injury or structural branching damage shall be replaced at no cost to the Government.

-- End of Section --

## SECTION 02921A

SEEDING  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes
ASTM D 5883	(1996e1) Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

## U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1995) Federal Seed Act Regulations Part 201
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Surface Erosion Control Material;  
Chemical Treatment Material;  
Delivery Schedule;

Manufacturer's literature including physical characteristics, application and installation instructions for equipment, surface erosion control material and chemical treatment material.

## SD-06 Test Reports

Equipment Calibration;  
Soil Test;

## SD-07 Certificates

Seed;  
Delivered Topsoil;  
pH Adjuster;  
Fertilizer;  
Organic Material;  
Soil Conditioner;  
Pesticide;  
Maintenance Record;

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

- a. Seed. Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.
- b. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.
- c. pH Adjuster. Calcium carbonate equivalent and sieve analysis.
- d. Fertilizer. Chemical analysis and composition percent.
- e. Organic Material: Composition and source.
- f. Soil Conditioner: Composition and source.
- g. Mulch: Composition and source.
- h. Asphalt Adhesive: Composition.
- i. Pesticide. EPA registration number and registered uses.

## 1.3 SOURCE INSPECTION

The source of delivered topsoil shall be subject to inspection.

## 1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

## 1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

## 1.4.1.1 Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

## 1.4.1.2 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of

containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

#### 1.4.1.3 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

#### 1.4.2 Inspection

Seed shall be inspected upon arrival at the job site for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected. Other materials shall be inspected for compliance with specified requirements. The following shall be rejected: open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter; and topsoil that contains viable plants and plant parts. Unacceptable materials shall be removed from the job site.

#### 1.4.3 Storage

Materials shall be stored in designated areas. Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with seeding operation materials.

#### 1.4.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

#### 1.4.5 Time Limitation

Hydroseeding time limitation for holding seed in the slurry shall be a maximum 24 hours.

## PART 2 PRODUCTS

### 2.1 SEED

#### 2.1.1 Seed Classification

State-certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS Seed Act and applicable state seed laws.

#### 2.1.2 Permanent Seed Species and Mixtures

Permanent seed species and mixtures shall be proportioned by weight as follows:

<u>Botanical Name</u>	<u>Common Name</u>	<u>Mixture Percent by Weight</u>	<u>Percent Pure Live Seed</u>
LAWN SEED			
Festuca Longifolia	Hard Fescue	80	75
Festuca Rubra	Red Fescue	20	75

2.1.3 Temporary Seed Species

Temporary seed species for surface erosion control or overseeding shall be as follows:

<u>Botanical Name</u>	<u>Common Name</u>	<u>Percent Pure Live Seed</u>
Lolium Multiflorum	Annual Ryegrass	80

2.1.4 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.1.5 Seed Mixing

The mixing of seed may be done by the seed supplier prior to delivery, or on site as directed.

2.1.6 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300A EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the seed specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, sulfur, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

#### 2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

#### 2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

#### 2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

#### 2.3.2 Fertilizer

It shall be as recommended by the soil test. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

#### 2.3.3 Nitrogen Carrier Fertilizer

It shall be as recommended by the soil test. Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The fertilizer may be a liquid nitrogen solution.

#### 2.3.4 Organic Material

Organic material shall consist of either bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

##### 2.3.4.1 Bonemeal

Bonemeal shall be finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

##### 2.3.4.2 Rotted Manure

Rotted manure shall be unleached horse, chicken or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. It shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

##### 2.3.4.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, yard trimmings, or other wood waste material that is free of stones, sticks, soil, and toxic substances harmful to plants, and is fully composted or stabilized with nitrogen.

#### 2.3.4.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. Compost shall be derived from food; agricultural or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

#### 2.3.4.5 Worm Castings

Worm castings shall be screened from worms and food source, and shall be commercially packaged.

#### 2.3.5 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for use singly or in combination to meet the requirements of the soil test.

##### 2.3.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

##### 2.3.5.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized and applied according to the manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide, with an absorption capacity of 250-400 times its weight. Polymers shall also be added to the seed and be a starch grafted polyacrylonitrile, with graphite added as a tacky sticker. It shall have an absorption capacity of 100 plus times its weight.

##### 2.3.5.3 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

##### 2.3.5.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

#### 2.3.5.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

#### 2.4 WATER

Water shall be the responsibility of the Contractor, unless otherwise noted. Water shall not contain elements toxic to plant life.

#### 2.5 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

#### 2.6 SURFACE EROSION CONTROL MATERIAL

Surface erosion control material shall conform to the following:

##### 2.6.1 Surface Erosion Control Blanket

Blanket shall be machine produced mat of wood excelsior formed from a web of interlocking wood fibers; covered on one side with either knitted straw blanket-like mat construction; covered with biodegradable plastic mesh; or interwoven biodegradable thread, plastic netting, or twisted kraft paper cord netting.

##### 2.6.2 Surface Erosion Control Fabric

Fabric shall be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips shall have a minimum life of 6 months.

##### 2.6.3 Surface Erosion Control Net

Net shall be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

##### 2.6.4 Surface Erosion Control Chemicals

Chemicals shall be high-polymer synthetic resin or cold-water emulsion of selected petroleum resins.

##### 2.6.5 Hydrophilic Colloids

Hydrophilic colloids shall be physiologically harmless to plant and animal life without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids shall resist mold growth.

##### 2.6.6 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

### PART 3 EXECUTION

#### 3.1 INSTALLING SEED TIME AND CONDITIONS

##### 3.1.1 Seeding Time

Seed shall be installed from March to April for spring establishment; from May to June for summer establishment; and from September to October for fall establishment.

##### 3.1.2 Seeding Conditions

Seeding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed.

When special conditions warrant a variance to the seeding operations, proposed alternate times shall be submitted for approval.

##### 3.1.3 Equipment Calibration

Immediately prior to the commencement of seeding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. The calibration test results shall be provided within 1 week of testing.

##### 3.1.4 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection on site shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the seed species specified.

#### 3.2 SITE PREPARATION

##### 3.2.1 Finished Grade and Topsoil

The Contractor shall verify that finished grades are as indicated on drawings, and the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02300A EARTHWORK, prior to the commencement of the seeding operation.

##### 3.2.2 Application of Soil Amendments

###### 3.2.2.1 Applying pH Adjuster

The pH adjuster shall be applied as recommended by the soil test. The pH adjuster shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage operation.

###### 3.2.2.2 Applying Fertilizer

The fertilizer shall be applied as recommended by the soil test. Fertilizer shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage or hydroseeding operation.

#### 3.2.2.3 Applying Soil Conditioner

The soil conditioner shall be as recommended by the soil test. The soil conditioner shall be spread uniformly over the soil a minimum 1 inch depth and thoroughly incorporated by tillage into the soil to a maximum 4 inch depth.

#### 3.2.2.4 Applying Super Absorbent Polymers

Polymers shall be spread uniformly over the soil as recommended by the manufacturer and thoroughly incorporated by tillage into the soil to a maximum 4 inch depth.

#### 3.2.3 Tillage

Soil on slopes up to a maximum 3-horizontal-to-1-vertical shall be tilled to a minimum 4 inch depth. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum 2 inch depth by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure.

#### 3.2.4 Prepared Surface

##### 3.2.4.1 Preparation

The prepared surface shall be a maximum 1 inch below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be completed with a light raking to remove debris.

##### 3.2.4.2 Lawn Area Debris

Debris and stones over a minimum 5/8 inch in any dimension shall be removed from the surface.

##### 3.2.4.3 Protection

Areas with the prepared surface shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

#### 3.3 INSTALLATION

Prior to installing seed, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

##### 3.3.1 Installing Seed

Seeding method shall be Broadcast Seeding. Seeding procedure shall ensure even coverage. Gravity feed applicators, which drop seed directly from a hopper onto the prepared soil, shall not be used because of the difficulty in achieving even coverage, unless otherwise approved. Absorbent polymer powder shall be mixed with the dry seed at the rate recommended by the manufacturer.

#### 3.3.1.1 Rolling

The entire area shall be firmed with a roller not exceeding 90 pounds per foot roller width. Slopes over a maximum 3-horizontal-to-1 vertical shall not be rolled. Areas seeded with seed drills equipped with rollers shall not be rolled.

#### 3.3.2 Hydroseeding

Seed shall be mixed to ensure broadcast at the rate of 150 pounds per 1000 square feet. Seed and fertilizer shall be added to water and thoroughly mixed to meet the rates specified. The time period for the seed to be held in the slurry shall be a maximum 24 hours. Wood cellulose fiber mulch and tackifier shall be added at the rates recommended by the manufacturer after the seed, fertilizer, and water have been thoroughly mixed to produce a homogeneous slurry. Slurry shall be uniformly applied under pressure over the entire area. The hydroseeded area shall not be rolled.

#### 3.3.3 Mulching

##### 3.3.3.1 Wood Cellulose Fiber, Paper Fiber, and Recycled Paper

Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

#### 3.3.4 Watering Seed

Watering shall be started immediately after completing the seeding of an area. Water shall be applied to supplement rainfall at a rate sufficient to ensure moist soil conditions to a minimum 1 inch depth. Run-off and puddling shall be prevented. Watering trucks shall not be driven over turf areas, unless otherwise directed. Watering of other adjacent areas or plant material shall be prevented.

#### 3.4 SURFACE EROSION CONTROL

##### 3.4.1 Surface Erosion Control Material

Where indicated or as directed, surface erosion control material shall be installed in accordance with manufacturer's instructions. Placement of the material shall be accomplished without damage to installed material or without deviation to finished grade.

##### 3.4.2 Temporary Seeding

The application rate shall be 150 pounds per acre. When directed during contract delays affecting the seeding operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded in accordance with temporary seed species listed under Paragraph SEED.

##### 3.4.2.1 Soil Amendments

When soil amendments have not been applied to the area, the quantity of 1/2 of the required soil amendments shall be applied and the area tilled in accordance with paragraph SITE PREPARATION. The area shall be watered in accordance with paragraph Watering Seed.

#### 3.4.2.2 Remaining Soil Amendments

The remaining soil amendments shall be applied in accordance with the paragraph Tillage when the surface is prepared for installing seed.

### 3.5 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight certificates shall be retained as a record of the amount used. The amount of material used shall be compared with the total area covered to determine the rate of application used. Differences between the quantity applied and the quantity specified shall be adjusted as directed.

### 3.6 RESTORATION AND CLEAN UP

#### 3.6.1 Restoration

Existing turf areas, pavements, and facilities that have been damaged from the seeding operation shall be restored to original condition at Contractor's expense.

#### 3.6.2 Clean Up

Excess and waste material shall be removed from the seeded areas and shall be disposed offsite. Adjacent paved areas shall be cleaned.

### 3.7 PROTECTION OF INSTALLED AREAS

Immediately upon completion of the seeding operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with Section 10430A EXTERIOR SIGNAGE.

### 3.8 SEED ESTABLISHMENT PERIOD

#### 3.8.1 Commencement

The seed establishment period to obtain a healthy stand of grass plants shall begin on the first day of seeding work under this contract and shall continue through the remaining life of the contract and end 3 months after the last day of the seeding operation required by this contract. Written calendar time period shall be furnished for the seed establishment period. When there is more than 1 seed establishment period, the boundaries of the seeded area covered for each period shall be described. The seed establishment period shall be coordinated with Sections 02922A SODDING, 02923A SPRIGGING, and 02930A EXTERIOR PLANTING. The seed establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

#### 3.8.2 Satisfactory Stand of Grass Plants

Grass plants shall be evaluated for species and health when the grass

plants are a minimum 1 inch high.

#### 3.8.2.1 Lawn Area

A satisfactory stand of grass plants from the seeding operation for a lawn area shall be a minimum 100 grass plants per square foot. Bare spots shall be a maximum 9 inches square. The total bare spots shall be a maximum 2 percent of the total seeded area.

#### 3.8.3 Maintenance During Establishment Period

Maintenance of the seeded areas shall include eradicating weeds, insects and diseases; protecting embankments and ditches from surface erosion; maintaining erosion control materials and mulch; protecting installed areas from traffic; mowing; watering; and post-fertilization.

##### 3.8.3.1 Mowing

- a. Lawn Areas: Lawn areas shall be mowed to a minimum 3 inch height when the turf is a maximum 4 inches high. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.
- b. Field Areas: Field areas shall be mowed once during the season to a minimum 3 inch height. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

##### 3.8.3.2 Post-Fertilization

The fertilizer shall be applied as recommended by the soil test. A maximum 1/2 pound per 1000 square feet of actual available nitrogen shall be provided to the grass plants. The application shall be timed prior to the advent of winter dormancy and shall be made without burning the installed grass plants.

##### 3.8.3.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

##### 3.8.3.4 Repair or Reinstall

Unsatisfactory stand of grass plants and mulch shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph SITE PREPARATION.

##### 3.8.3.5 Maintenance Record

A record of each site visit shall be furnished, describing the maintenance work performed; areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

-- End of Section --

## SECTION 02930A

EXTERIOR PLANTING  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300 (1995) Tree Care Operations - Trees, Shrubs  
and Other Woody Plant Maintenance

## AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1 (1996) Nursery Stock

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602 (1995a) Agricultural Liming Materials

ASTM D 4972 (1995a) pH of Soils

ASTM D 5268 (1992; R 1996) Topsoil Used for Landscaping  
Purposes

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Plant Establishment Period;

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

## SD-04 Samples

## Delivered Topsoil;

Samples taken from several locations at the source.

## Soil Amendments;

A 10 pound sample.

Mulch;

A 10 pound sample.

#### SD-06 Test Reports

Soil Test;

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

#### SD-07 Certificates

Plant Material;  
Topsoil;  
pH Adjuster;  
Fertilizer;  
Organic Material;  
Soil Conditioner;  
Organic Mulch;  
Pesticide;  
Delivery Schedule;

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

- a. Plant Material: Classification, botanical name, common name, size, quantity by species, and location where grown.
- b. Topsoil: Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.
- c. pH Adjuster: Sieve analysis and calcium carbonate equivalent.
- d. Fertilizer: Chemical analysis and composition percent.
- e. Organic Material: Composition and source.
- f. Soil Conditioner: Composition and source.
- g. Organic Mulch: Composition, source.
- h. Pesticide. EPA registration number and registered uses.

### 1.3 SOURCE INSPECTIONS

The nursery or source of plant material and the source of delivered topsoil shall be subject to inspection.

### 1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

#### 1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

#### 1.4.1.1 Plant Material Identification

Plant material shall be identified with attached, durable, waterproof labels and weather-resistant ink, stating the correct botanical plant name and size. All plants need not be marked, only samples are required.

#### 1.4.1.2 Protection During Delivery

Plant material shall be protected during delivery to prevent desiccation and damage to the branches, trunk, root system, or earth ball. Branches shall be protected by tying-in. Exposed branches shall be covered during transport. Plants shall be handled by their root balls or containers only and not by their tops. Plants are to be set down carefully and not dropped.

#### 1.4.1.3 Delivered Topsoil

Prior to the delivery of any topsoil, the availability of topsoil shall be verified in paragraph TOPSOIL. A soil test shall be provided for delivered topsoil.

#### 1.4.1.4 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

#### 1.4.1.5 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

#### 1.4.2 Inspection

Plant material shall be well shaped, vigorous and healthy with a healthy, well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion. Plant material shall be checked for unauthorized substitution and to establish nursery grown status. Plant material showing desiccation, abrasion, sun-scald injury, disfigurement, or unauthorized substitution shall be rejected. The plant material shall exhibit typical form of branch to height ratio; and meet the caliper and height measurements specified. Plant material that measures less than specified, or has been poled, topped off or headed back, shall be rejected. Container-grown plant material shall show new fibrous roots and the root mass shall contain its shape when removed from the container. Plant material with broken or cracked balls; or broken containers shall be rejected. Pot-bound container-grown plants shall be rejected. Other materials shall be inspected for compliance with paragraph PRODUCTS. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 1-1/2 inch diameter shall be rejected. Unacceptable material shall be removed from the job site.

#### 1.4.3 Storage

#### 1.4.3.1 Plant Material Storage

Plant material not installed on the day of arrival at the site shall be stored and protected in designated areas. Plant material shall not be stored longer than 30 days. Plant material shall be protected from direct exposure to wind and sun. All plant material shall be kept in a moist condition by watering with a fine mist spray until installed.

#### 1.4.3.2 Other Material Storage

Storage of other material shall be in designated areas. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with planting operation material.

#### 1.4.4 Handling

Plant material shall not be injured in handling. Cracking or breaking the earth ball of balled and burlapped plant material shall be avoided. Plant material shall not be handled by the trunk or stems. Materials shall not be dropped from vehicles.

#### 1.4.5 Time Limitation

Except for container-grown plant material, the time limitation from delivering to installing plant material shall be a maximum 40 days. The time limitation between installing the plant material and placing the mulch shall be a maximum 48 hours.

### 1.5 WARRANTY

Furnished plant material shall have a warranty for plant growth to be in a vigorous growing condition for a minimum 12 month period from the date of final acceptance. A minimum 12 month calendar time period for the warranty of plant growth shall be provided regardless of the contract time period. When plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced under this warranty. Plants shall be covered by an additional one year plant replacement warranty.

## PART 2 PRODUCTS

### 2.1 PLANT MATERIAL

#### 2.1.1 Plant Material Classification

The plant material shall be nursery grown stock conforming to ANLA Z60.1 and shall be the species specified.

#### 2.1.2 Substitutions

Substitutions will not be permitted without written request and approval from the Contracting Officer.

#### 2.1.3 Quality

Well shaped, well grown, vigorous plant material having healthy and well branched root systems in accordance with ANLA Z60.1 shall be provided.

Plant material shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems, which may occur from the digging and preparation for shipment, method of shipment, or shipment. Plant quality is determined by the growing conditions; method of shipment to maintain health of the root system; and growth of the trunk and crown as follows.

#### 2.1.4 Growing Conditions

Plant material shall be grown under climatic conditions similar to those at the project site.

#### 2.1.5 Method of Shipment to Maintain Health of Root System

##### 2.1.5.1 Balled and Burlapped (BB) Plant Material

Ball size and ratio shall be in accordance with ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. The root ball shall be completely wrapped with biodegradable burlap or other suitable material and securely laced with biodegradable twine.

##### 2.1.5.2 Balled and Potted (Pot) Plant Material

Ball size and ratio shall be in accordance with ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. Removal shall be done by hand digging or mechanical devices. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. Container shall be used to retain the ball unbroken. Container shall be rigid to hold ball shape and protect root mass during shipping.

##### 2.1.5.3 Balled and Platform (BP) Plant Material

Ball size and ratio shall be in accordance with ANLA Z60.1. Plants shall be prepared as balled and burlapped plant material and securely fastened to wood platform for shipping.

##### 2.1.5.4 Container-Grown (C) Plant Material

Container size shall be in accordance with ANLA Z60.1. Plant material shall be grown in a container over a duration of time for new fibrous roots to have developed and for the root mass to retain its shape and hold together when removed from the container. The container shall be sufficiently rigid to hold ball shape and protect root mass during shipping. Pot bound plants will not be accepted.

#### 2.1.6 Growth of Trunk and Crown

##### 2.1.6.1 Deciduous Trees

A height to caliper relationship shall be provided in accordance with ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

- a. Single stem: The trunk shall have a persistent main leader.
- b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there shall be no division of the trunk which branches more than 6 inches from ground level.
- c. Specimen: The tree provided shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

#### 2.1.6.2 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA Z60.1. Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

#### 2.1.6.3 Coniferous Plant Material

Coniferous plant material shall have the height-to-spread ratio recommended by ANLA Z60.1. The coniferous evergreen trees shall not be "poled" or the leader removed. Acceptable plant material shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

#### 2.1.6.4 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANLA Z60.1. Acceptable plant material shall be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

#### 2.1.6.5 Ground Cover, Perennial, and Vine Plant Material

Ground cover, perennial, and vine plant material shall have the minimum number of runners and length of runner recommended by ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

#### 2.1.7 Plant Material Size

Plant material shall be furnished in sizes indicated. Plant material larger in size than specified may be provided at no additional cost to the Government.

#### 2.1.8 Plant Material Measurement

Plant material measurements shall be in accordance with ANLA Z60.1.

### 2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300A EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the

plant material specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter.

## 2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, and organic material meeting the following requirements.

### 2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

#### 2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

#### 2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

#### 2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

### 2.3.2 Fertilizer

It shall be as recommended by the soil test. Fertilizer shall be controlled release commercial grade; free flowing, pellet or tablet form; uniform in composition; and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU).

Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

### 2.3.3 Organic Material

Organic material shall consist of recycled compost.

#### 2.3.3.1 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55

percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

## 2.4 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region. Rotted manure is not recommended to be used as a mulch because it would encourage surface rooting of the plant material and weeds.

### 2.4.1 Organic Mulch

Organic mulch materials shall be native to the project site and consist of shredded hardwood bark.

#### 2.4.1.1 Shredded Hardwood Bark

Locally shredded material shall be utilized. It shall be free of excess white wood.

## 2.5 WOOD STAKING MATERIAL

Wood stakes shall be hardwood or fir; rough sawn; free from knots, rot, cross grain, or other defects that would impair their strength.

### 2.5.1 Bracing Stake

Wood bracing stakes shall be a minimum 2 x 2 inch square and a minimum 8 feet long with a point at one end. Stake shall be set without damaging rootball.

## 2.6 METAL STAKING AND GUYING MATERIAL

### 2.6.1 Guying Material

Metal guying material shall be a minimum 12 gauge wire. Multi-strand cable shall be woven wire. Guying material tensile strength shall conform to the size of tree to be held firmly in place.

### 2.6.2 Turnbuckle

Metal turnbuckles shall be galvanized or cadmium-plated steel, and shall be a minimum 3 inches long with closed screw eyes on each end. Screw thread tensile strength shall conform to the size of tree to be held firmly in place.

## 2.7 PLASTIC STAKING AND GUYING MATERIAL

Plastic shall consist of recycled plastic product made for holding plant material firmly in place. Plastic shall not be used for deadmen.

## 2.8 RUBBER GUYING MATERIAL

Rubber chafing guards, consisting of recycled material, shall be used to protect tree trunks and branches when metal guying material is applied. The material shall be the same color throughout the project. Length shall

be a minimum 1.5 times the circumference of the plant trunk at its base.

## 2.9 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life. Contractor shall provide all equipment necessary to distribute water on site to plantings.

## 2.10 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

## PART 3 EXECUTION

### 3.1 INSTALLING PLANT MATERIAL TIME AND CONDITIONS

#### 3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be installed from Oct. 15 to April 15.

#### 3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be installed from Oct. 15 to April 15.

#### 3.1.3 Plant Material Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for approval.

#### 3.1.4 Tests

##### 3.1.4.1 Percolation Test

Test for percolation shall be done to determine positive drainage of plant pits and beds. A positive percolation shall consist of a minimum 1 inch per 3 hours; when a negative percolation test occurs, a shop drawing shall be submitted indicating the corrective measures.

##### 3.1.4.2 Soil Test

Delivered topsoil, excavated plant pit soil, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection onsite shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the plant material specified.

### 3.2 SITE PREPARATION

### 3.2.1 Finished Grade, Topsoil and Underground Utilities

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 02300A EARTHWORK, prior to the commencement of the planting operation. The location of underground utilities and facilities in the area of the planting operation shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

### 3.2.2 Layout

Bed outlines shall be marked on the project site before any excavation is made. Plant material locations may be adjusted with approval to meet field conditions.

### 3.2.3 Protecting Existing Vegetation

When there are established lawns in the planting area, the turf shall be covered and/or protected during planting operations. Existing trees, shrubs, and plant beds that are to be preserved shall be barricaded along the dripline to protect them during planting operations.

## 3.3 EXCAVATION

### 3.3.1 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to plant material location, type of plant and planting method shall be submitted for approval.

### 3.3.2 Turf Removal

Where the planting operation occurs in an existing lawn area, the turf shall be killed with an herbicide utilizing glyphosate.

### 3.3.3 Plant Pits

Plant pits for ball and burlapped or container plant material shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits shall be dug a minimum 50 percent wider than the ball or root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used.

## 3.4 INSTALLATION

### 3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with or slightly above the grade at which it was grown.

### 3.4.2 Backfill Soil Mixture

The backfill soil mixture may be a mix of topsoil and soil amendments suitable for the plant material specified. When practical, the excavated soil from the plant pit that is not amended provides the best backfill and shall be used. Soil amendment (compost) shall be worked into entire bed areas only, not used as backfill for plants not located in beds.

### 3.4.3 Backfill Procedure

Prior to backfilling, all metal, wood, synthetic products, or treated burlap devices shall be removed from the ball or root system avoiding damage to the root system. The backfill procedure shall remove air pockets from around the root system. Additional requirements are as follows.

#### 3.4.3.1 Balled and Burlapped, and Balled and Platformed Plant Material

Biodegradable burlap and tying material shall be carefully opened and cut back from the top a minimum 1/3 depth from the top of the root ball. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

#### 3.4.3.2 Container-Grown and Balled and Potted Plant Material

The plant material shall be carefully removed from containers that are not biodegradable. Prior to setting the plant in the pit, a maximum 1/4 depth of the root mass, measured from the bottom, shall be spread apart to promote new root growth. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

#### 3.4.3.3 Earth Berm

An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

#### 3.4.4 Plant Bed

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas. Earth berms shall be provided.

#### 3.4.5 Watering

Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated.

#### 3.4.6 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity.

##### 3.4.6.1 Two Bracing Stakes

Trees from 6 to 8 feet height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of

guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling.

#### 3.4.6.2 Three Ground Stakes

Trees over a minimum 8 feet height and less than a maximum 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced equidistantly around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over maximum 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

### 3.5 FINISHING

#### 3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped smoothly as indicated on the landscape plan. The installed area shall be raked and smoothed while maintaining the earth berms.

#### 3.5.2 Placing Mulch

The placement of mulch shall occur a maximum 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 4 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines off the trunks of trees, and shall be kept off buildings, sidewalks and other facilities. Mulch shall be spread 2 inches deep in areas surrounding herbaceous plants.

#### 3.5.3 Pruning

Pruning shall be accomplished by trained and experienced personnel. The pruning of trees shall be in accordance with ANSI A300. Only dead, broken, or cross-branched material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

### 3.6 MAINTENANCE DURING PLANTING OPERATION

Installed plant material shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed to prevent desiccation and shall continue until the plant establishment period commences. Installed areas shall be kept free of weeds, grass, and other undesired vegetation. The maintenance includes maintaining the mulch, watering, and adjusting settling.

### 3.7 RESTORATION AND CLEAN UP

#### 3.7.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

### 3.7.2 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite. Adjacent paved areas shall be cleared.

## 3.8 PLANT ESTABLISHMENT PERIOD

### 3.8.1 Commencement

Upon final acceptance, the plant establishment period for maintaining exterior plantings in a healthy growing condition shall commence on the first day of exterior planting work under this contract and shall continue through the remaining life of the contract and end 12 months after the last day of exterior planting required by this contract. Written calendar time period shall be furnished for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated with Sections 02921A SEEDING; 02922A SODDING; and 02923A SPRIGGING. The plant establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

### 3.8.2 Maintenance During Establishment Period

Maintenance of plant material shall include straightening plant material, straightening stakes; tightening guying material; correcting girdling; supplementing mulch; pruning dead or broken branch tips; watering; eradicating weeds, insects and disease; post-fertilization; and removing and replacing dead or unhealthy plants.

#### 3.8.2.1 Watering Plant Material

The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is estimated to be the equivalent of 1 inch absorbed water per week, delivered in the form of rain or augmented by watering. Run-off, puddling and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas.

#### 3.8.2.2 Weeding

Grass and weeds in the installed areas shall not be allowed to reach a maximum 3 inches height before being completely removed, including the root system.

#### 3.8.2.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

#### 3.8.2.4 Post-Fertilization

The plant material shall be topdressed at least once during the period of establishment with controlled release fertilizer, reference paragraph SOIL AMENDMENTS. Apply at the rate of 2 pounds per 100 square feet of plant

pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy.

#### 3.8.2.5 Plant Pit Settling

When settling occurs to the backfill soil mixture, additional backfill soil shall be added to the plant pit or plant bed until the backfill level is equal to the surrounding grade. Serious settling that affects the setting of the plant in relation to the maximum depth at which it was grown requires replanting in accordance with paragraph INSTALLATION. The earth berm shall be maintained.

#### 3.8.2.6 Maintenance Record

A record shall be furnished describing the maintenance work performed, the quantity of plant losses, diagnosis of the plant loss, and the quantity of replacements made on each site visit.

#### 3.8.3 Unhealthy Plant Material

A tree shall be considered unhealthy or dead when the main leader has died back, or 25 percent or more of the crown has died. A shrub shall be considered unhealthy or dead when 25 percent or more of the plant has died. This condition shall be determined by scraping on a branch an area 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for unhealthy plant material and shall provide recommendations for replacement. Unhealthy or dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

#### 3.8.4 Replacement Plant Material

Unless otherwise directed, plant material shall be provided for replacement in accordance with paragraph PLANT MATERIAL. Replacement plant material shall be installed in accordance with paragraph INSTALLATION, and recommendations in paragraph PLANT ESTABLISHMENT PERIOD. Plant material shall be replaced in accordance with paragraph WARRANTY. Replacement plants shall be provided with a 12 month warranty.

-- End of Section --

## SECTION 02935A

EXTERIOR PLANT MATERIAL MAINTENANCE  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300 (1995) Tree Care Operations - Trees, Shrubs  
and Other Woody Plant Maintenance

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602 (1995a) Agricultural Liming Materials

ASTM D 4972 (1995a) pH of Soils

ASTM D 5883 (1996e1) Use of Rotary Kiln Produced  
Expanded Shale, Clay or Slate (ESCS) as a  
Mineral Amendment in Topsoil Used for  
Landscaping and Related Purposes

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Chemical Treatment Material;

Manufacturer's literature including physical characteristics, application and installation instructions for chemical treatment material.

## Work Plan and Schedule;

Contractor's work plan and schedules.

## Application of Pesticide;

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active

ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

#### SD-06 Test Reports

##### Soil Tests;

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

#### SD-07 Certificates

pH Adjuster;  
Fertilizer;  
Mulch;  
Pesticide;

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

- a. pH Adjuster. Calcium carbonate equivalent and sieve analysis.
- b. Fertilizer. Chemical analysis and composition percent.
- c. Mulch: Composition and source.
- d. Pesticide. EPA registration number and registered uses.

### 1.3 DELIVERY, INSPECTION, STORAGE, AND HANDLING

#### 1.3.1 Delivery Schedule

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

#### 1.3.2 Delivery of Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

#### 1.3.3 Storage

Materials shall be stored in designated areas. Lime and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with seeding operation materials.

#### 1.3.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

## PART 2 PRODUCTS

### 2.1 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material meeting the following requirements. Vermiculite shall not be used.

#### 2.1.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, sulfur, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified or in place.

##### 2.1.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

##### 2.1.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a No. 8 sieve and a minimum 97 percent shall pass through a No. 60 sieve.

##### 2.1.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 35 percent shall pass through a No. 60 sieve.

#### 2.1.2 Fertilizer

Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a nitrogen-phosphorus-potassium ratio. The nutrients ratio shall be 5 percent nitrogen, 10 percent phosphorus, and 5 percent potassium. The fertilizer shall be derived from sulfur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

##### 2.1.3 Nitrogen Carrier Fertilizer

Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The nutrients ratio shall be 10 percent nitrogen, 5 percent phosphorus, and 5 percent potassium. The fertilizer may be a liquid nitrogen solution.

##### 2.1.4 Organic Material

Organic material shall consist of bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

###### 2.1.4.1 Bonemeal

Bonemeal shall be finely ground, steamed bone product containing from 2 to

4 percent nitrogen and 16 to 40 percent phosphoric acid.

#### 2.1.4.2 Rotted Manure

Rotted manure shall be unleached horse, chicken or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. It shall contain no chemicals or ingredients harmful to plants.

The manure shall be heat treated to kill weed seeds.

#### 2.1.4.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall consist of ground bark, sawdust, yard trimmings, or other wood waste material that is free of stones, sticks, soil, and toxic substances harmful to plants, and is fully composted or stabilized with nitrogen.

#### 2.1.4.4 Recycled Compost

Recycled compost shall be well decomposed, stable, weed free organic matter source. Compost shall be derived from food; agricultural or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

#### 2.1.4.5 Worm Castings

Worm castings shall be screened from worms and food source, commercially packaged.

#### 2.1.5 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for use singly or in combination.

##### 2.1.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Green sand shall be balanced with the inclusion of trace minerals and nutrients.

##### 2.1.5.2 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

##### 2.1.5.3 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

#### 2.1.5.4 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall conform to ASTM D 5883.

### 2.2 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region. Rotted manure shall not be used.

#### 2.2.1 Organic Mulch

Organic mulch materials shall be native to the project vicinity and consist of shredded hardwood bark, for use when remulching trees, shrubs, and ground covers.

##### 2.2.1.1 Shredded Hardwood Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

### 2.3 WATER

Water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life.

### 2.4 PESTICIDE

Pesticide shall be an insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

### 2.5 HERBICIDE

Herbicide shall be EPA registered and approved; furnished for preemergence and postemergence application for crabgrass control and broad leaf weed control and complying with Federal Insecticide, Fungicide, and Rodenticide Act (Title 7 U.S.C. Section 136) for requirements on Contractor's licensing, certification, and record keeping. Contractor shall keep records of all pesticide applications and forward data monthly to Contracting Officer. Record keeping format shall be submitted to Contracting Officer for approval.

## PART 3 EXECUTION

### 3.1 SOIL TESTS

Contractor shall perform soil tests in accordance with ASTM D 4972.

### 3.2 SITE PREPARATION

#### 3.2.1 Applying pH Adjuster

pH adjuster shall be applied at a rate determined based upon soil test recommendations.

### 3.2.2 Applying Fertilizer

Apply fertilizer at rate as determined based upon soil test recommendations.

### 3.3 MULCHING

Mulch applied as a topdressing to maintain a total 4 inches of mulch depth.

### 3.4 WATERING

Water to supplement rainfall shall be applied at a rate sufficient to ensure plant growth. Run-off and puddling shall be prevented. Watering trucks shall not be driven over turf areas, unless otherwise directed. Watering of other adjacent areas or plant material shall be prevented.

### 3.5 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

#### 3.5.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control.

#### 3.5.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended to prevent the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately. A pesticide plan shall be submitted.

### 3.6 GENERAL MAINTENANCE REQUIREMENTS

#### 3.6.1 Fertilization

Fertilizer shall be applied as determined based upon soil test recommendations. Application shall be timed prior to the advent of winter dormancy and performed without burning plants.

#### 3.6.2 Pesticide Treatment

Pesticide treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

#### 3.6.3 Irrigation Maintenance

The Contractor shall service and repair controller, pumps, valves, couplers, sprinklers, sprinkler heads, piping; and shall be responsible for

winterization and startup. Sprinkler heads shall direct water away from building. The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone; the amount of water required shall be the equivalent of 1 inch absorbed water per week. Amount of irrigation watering shall take amounts of rain into account.

#### 3.6.4 Maintenance Record

A record of each site visit shall be furnished, describing:

- a. Maintenance work performed.
- b. Areas repaired or reinstalled.
- c. Diagnosis for unsatisfactory stand of grass.
- d. Diagnosis for unsatisfactory stand of plant material in planting bed.
- e. Condition of trees.
- f. Condition of shrubs.
- g. Quantity and diagnosis of plant loss.
- h. Irrigation system.

#### 3.7 GRASS PLANT QUALITY

Lawn areas shall be evaluated for species and health when the grass plants are a minimum 1 inch high. The living grass area shall be maintained to be uniform in color and leaf texture; and free from weeds and other undesirable growth. The living grass area shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 1 inch in diameter, woody plant roots, and other materials detrimental to a healthy stand of grass plants. Broadleaf weeds and patches of foreign grasses shall be a maximum 2 percent of the total area.

##### 3.7.1 Lawn Area

A satisfactory stand of grass plants for a lawn area shall be a minimum 20 grass plants per square foot. Bare spots shall be a maximum 6 inches square. The total bare spots shall be a maximum 2 percent of the total area.

#### 3.8 LAWN AREA MAINTENANCE

##### 3.8.1 Mowing

Lawn and field areas shall be mowed throughout the growing season to meet the requirements of paragraph GRASS PLANT QUALITY. Cutting height shall be adjusted according to type of grass. Frequency of mowing shall be adjusted so that no more than 1/4 of leaf length is removed during a cutting.

##### 3.8.1.1 Lawn Areas

Lawn areas shall be mowed to a minimum 1-1/2 inch height when the turf is a maximum 2-1/2 inches high. Remove clippings when the amount cut prevents

sunlight from reaching the ground surface.

### 3.8.2 Turf Trimming

Turf adjoining paved areas, planting beds and trees shall be kept neatly trimmed at all times, essentially after each mowing. String trimmers at trees and shrubs will be prohibited.

### 3.8.3 Aeration

Turf areas shall be aerated once per year using approved devices. Coring shall be performed by pulling soil plugs to minimum of 4 inches. Soil plugs produced in turf areas shall be left in place.

### 3.8.4 Lime

Lime for pH modification shall be applied as required to meet the requirements of paragraph GRASS PLANT QUALITY.

### 3.8.5 Herbicide Weed Control

Two or more applications of a pre-emergent herbicide and of a post-emergent herbicide shall be performed to meet the requirements of paragraph GRASS PLANT QUALITY.

### 3.8.6 Turf Fertilization Program

A regular program of fertilization shall be established to include a spring feeding and early summer feeding to meet the requirements of paragraph GRASS PLANT QUALITY. A total of four pounds of Nitrogen per 1000 square feet shall be applied annually. Additional one pound Nitrogen applications shall be provided as grass color warrants.

## 3.9 PLANTING BED MAINTENANCE

### 3.9.1 Trimming

Spent flower heads shall be removed. Seasonal succession of bloom requires removal for new plant or trimming back bulb foliage.

### 3.9.2 Irrigation of Planting Beds

Run-off, puddling and wilting, watering of other adjacent areas or existing plant material shall be prevented.

### 3.9.3 Weed Control

Grass and weeds in planting beds shall be completely removed before reaching 3 inches in height.

## 3.10 PLANT MATERIAL QUALITY

### 3.10.1 General Requirements

Plant material shall be maintained as well shaped, well grown, vigorous plant material having healthy root systems. The plant material shall be maintained as free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems. Plant quality is determined

by the growing conditions; climate and microclimate of the site for maintaining a healthy root system; and growth of the trunk and crown as follows.

### 3.10.2 Growth of Trunk and Crown

#### 3.10.2.1 Deciduous Trees

Deciduous tree height to caliper relationship shall be maintained. Height of branching shall bear a relationship to the size and species of the tree and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

- a. Single stem: The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.
- b. Multi-stem: To be considered a stem, there shall be no division of the trunk which branches more than 6 inches from ground level.
- c. Specimen: The tree shall be well branched and pruned naturally according to the species. The form of growth desired, shall be indicated.

#### 3.10.2.2 Deciduous Shrubs

Deciduous shrub height to number of primary stems ratio shall be maintained. Shrubs shall be maintained as well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the site.

#### 3.10.2.3 Coniferous Plant Material

Coniferous plant material height-to-spread ratio shall be maintained. The coniferous evergreen trees shall not be "poled" or the leader removed. The plant material shall be maintained to be well shaped and trimmed in accordance with the plant's natural form. The form of growth desired shall be indicated.

#### 3.10.2.4 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material height-to-spread ratio shall be maintained. The plant material shall be shaped to be recognized by the trade as typical for the variety grown in the region of the site.

#### 3.10.2.5 Ground Cover and Vine Plant Material

Ground cover and vine plant material shall be maintained to have a heavy, well developed, and balanced crown with vigorous, well developed root system.

### 3.11 SHRUB AND HEDGE MAINTENANCE

#### 3.11.1 Pruning

Pruning shall be performed to ensure the following:

- a. Safety.
- b. Quality (size, height, and shape).

- c. Health (removing broken, diseased branches).
- d. Rejuvenation (removing one third to one half of the older stems or branches).
- e. Visibility (signs, building entrances, motorist line of sight).

Shrubs shall be pruned to the requirements of paragraph PLANT MATERIAL QUALITY. Pruning shall be accomplished by trained and experienced personnel in accordance with ANSI A300. The typical growth habit of individual plant material or the theme shape of the hedge shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed.

#### 3.11.2 Irrigation of Shrubs and Hedges

Run-off, puddling and wilting shall be prevented.

#### 3.11.3 Shrub Fertilization Program

A regular program of fertilization shall be established to include a fall feeding to meet the requirements of paragraph PLANT MATERIAL QUALITY. Use industry standards for foliage and root fertilizing the plant material inventoried.

### 3.12 TREE MAINTENANCE

#### 3.12.1 Pruning of Trees

Pruning shall be performed to ensure the following:

- a. Safety.
- b. Quality (size, height).
- c. Health (removing broken, diseased wood branches).
- d. Rejuvenation (removing one third to one half of the older stems or branches).
- e. Visibility (signs, building entrances, motorist line of sight).

Trees shall be pruned to meet the requirements of paragraph PLANT MATERIAL QUALITY. Pruning shall be accomplished by trained and experienced personnel in accordance with ANSI A300. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

#### 3.12.2 Irrigation of Trees

Run-off, puddling and wilting shall be prevented.

#### 3.12.3 Tree Fertilization Program

A regular program of fertilization shall be established to include a fall

feeding to meet the requirements of paragraph PLANT MATERIAL QUALITY. Use industry standards for foliage and root fertilizing the plant material inventoried.

#### 3.12.4 Unhealthy Plant Material

A tree shall be considered unhealthy or dead when the main leader has died back, or 25 percent or more of the crown has died. A shrub shall be considered unhealthy or dead when 25 percent or more of the plant has died. This condition shall be determined by scraping on a branch an area 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for unhealthy plant material and shall provide recommendations for replacement. Unhealthy or dead plant material shall be removed immediately replaced during the next planting season.

#### 3.13 RESTORATION AND CLEAN UP

##### 3.13.1 Restoration

Existing turf areas, pavements, and facilities that have been damaged from the maintenance operations shall be restored to original condition at Contractor's expense.

##### 3.13.2 Clean Up

Excess and waste material shall be removed from the maintenance areas and disposed off site. Adjacent paved areas shall be cleaned as determined by the Contracting Officer.

#### 3.14 CLEANING OF PAVED AREAS

Grass, weeds, leaves, and debris from mowing, clipping, and pruning shall be removed immediately. Excess and waste material shall be removed from paved areas and disposed off site. Debris, leaves shall be removed weekly.

-- End of Section --

## SECTION 02981

IRRIGATION SYSTEM  
10/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

ASTM D 1784	(1999) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2241	(1974) Polyvinylchloride (PVC) Plastic Pipe (SDR-PR)
ASTM D 2466	(1997) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1973)a Solvent Cements for PVC Plastic Pipe and Fittings
ASTM D 2774	(1972) Recommended Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1999) Reduced Pressure Principle Backflow Preventers

## AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS

AWWA C500	(1971) Gate Valves 3-Inch through 48-Inch Water and Other Liquids
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## 1.2 WORK SPECIFIED HEREIN

- a. This section describes the labor, materials and installation requirements necessary to design and install an automatic irrigation system adequate to irrigate all planted areas other than turf, in this project.

- b. Excavation, trenching and backfilling for irrigation systems are in Section 02224.
- c. Electrical work shall conform to the National Electric Code, latest edition.

### 1.3 PERFORMANCE REQUIREMENTS

System shall operate with a minimum water pressure of 58-60 pounds per square inch (psi) at connection to backflow prevention device and 25 psi at the last head in each zone.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-01 Design Analysis

Design Analysis, Calculations, and Spare Parts; G, AE

Design analyses and pressure calculations verifying that system will provide the irrigation requirements. Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field-tests. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, with current unit prices and source of supply.

#### SD-02 Shop Drawings

Shop Drawings; G, AE

The irrigation systems shall be industrial commercial systems, Toro, Rainbird or approved equal. Detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Drawing shall include of a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers.

#### SD-10 Record Drawings

Record and As-Built Drawings;

The Contractor shall provide and keep up to date a complete "as-built" record set of blue line, ozalid prints which shall be corrected daily and show every change from the original drawings and specifications and the exact "as-built" locations, sizes, and

kinds of equipment. Prints for this purpose may be obtained from the Contracting Officer at no cost. This set of drawings shall be kept on the site and shall be used only as a record set.

These drawings shall also serve as work progress sheets. The Contractor shall make neat and legible annotations thereon daily as the work proceeds, showing the work as actually installed. These drawings shall be available at all times for inspection and shall be kept in a location designated by the Contracting Officer.

The Contractor shall dimension from two permanent points of reference, building corners, sidewalk, road intersections, road station points, etc., the location of the following items (if applicable):

- a) Connection to existing water lines.
- b) Connection to existing electrical power.
- c) All valves and backflow devices.
- d) Routing of all irrigation (dimension max. 200 feet along routing).
- e) Irrigation controllers.
- f) Routing of control wiring.
- g) Quick coupling valves.
- h) Drip system riser assemblies
- i) Other related equipment as directed by the Contracting Officer.
- j) All lettering on drawings shall be minimum 1/8 inch in size.

On or before the date of final inspection, the Contractor shall deliver the corrected and approved drawings to the Contracting Officer. Delivery of the drawings will not relieve the Contractor of the responsibility of furnishing required information that may be omitted.

#### 1.5 CERTIFICATES

The material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier or product manufacture and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

#### 1.6 MAINTENANCE MANUALS

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to field-testing and the remainder upon acceptance. Manuals shall be approved prior to the field-training course. Operating manuals shall detail the step-by-step procedures required for system startup, operation and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features.

Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

#### 1.7 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the Weather; excessive humidity and temperature variation; direct sunlight (in case of plastic or rubber materials); and dirt, dust, or other contaminants.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer who has produced similar systems which have performed well for a minimum period of 2 years prior to bid opening.

#### 2.2 SPARE PARTS

The following extra stock shall be provided: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

#### 2.3 PIPING MATERIALS

##### 2.3.1 Mainline Pipe and Fittings

- a. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM D 1784, with an integral belled end.
- b. Use Class 200, SDR-21, rated at 200 psi, conforming to the dimensions and tolerances established by ASTM D 2241.

Use Schedule 40. Type 1, PVC solvent weld fittings conforming to ASTM D 2466 and ASTM D 1784. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM D 2564.

- c. Provide metallic tracer tape or wire (capable of being detected with a metal detector) adjacent to all PVC pipe at time of installation (as specified on drawings).

##### 2.3.2 Lateral Pipe and Fittings

- a. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM D 1784, with and integral belled end suitable for solvent welding.
- b. Use Class 200 SDR-26, rated at 200 psi, conforming to the dimensions and tolerances established by ASTM Standards. Fittings for PVC pipe shall be scheduled 40, Type I, PVC 41 Solvent weld fittings- ASTM D 2466 & ASTM D 1784. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of a type approved by the pipe manufacturer.

- c. Provide metallic tracer tape or wire (capable of being detected with a metal detector) adjacent to all PVC pipe at time of installation (as shown on drawings).

#### 2.3.3 Sleeving

- a. Install separate sleeve beneath paved areas to route each run of irrigation pipe or wiring bundle.
- b. Sleeving material beneath pedestrian pavements shall be be PVC Class 200 pipe with solvent welded joints.
- c. Sleeving beneath drives and streets shall be scheduled 40 PVC pipe with solvent welded joints.
- d. Sleeving diameter; equal to twice that of the pipe or wiring bundle.

#### 2.3.4 Solvent Cement

Solvent cement shall conform to the requirements of ASTM D 2564.

### 2.4 SPRINKLER AND EMITTER HEADS

#### 2.4.1 Pop-Up Spray Heads

Pop-up spray heads shall conform to the requirements of FS W W-H0012200, Type II, Adjustable Class. Nozzle rises a minimum of 4 inches above body.

#### 2.4.2 Shrubbery Sprinkler Heads

Sprinkler heads shall be conical spray with adjustable coverage and designed as pop-ups at a height compatible with plant materials.

### 2.5 GATE VALVES

- a. Gate valves shall be brass and shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.
- b. Valves smaller than 3 inches shall be all bronze and shall conform to Federal Specification WW-V-54, Type 1.
- c. Valves 3 inches or larger shall be iron body, bronze mounted, and shall conform to AWWA C500.

### 2.6 QUICK COUPLING VALVES

Quick coupling valves shall have brass parts and shall be two-piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutdown of main. Lids shall be lockable vinyl with spring for positive closure on key removal.

### 2.7 CONTROL VALVES, ELECTRICAL

- a. Remote control valves shall be solenoid actuated globe valves of 3/4 - to (19.1 mm to 76.2 mm)-inch size, suitable for 24 VAC volts, 60 cycle, and designed to provide for shut-off in event of power failure. Valve shall be cast bronze or brass or plastic housing suitable for service at 150 psi operating pressure with external flow control adjustment for shut-off capability, external plug at diaphragm chamber to enable manual operation, filter in control chamber to prevent valve body clogging with debris, durable diaphragm, and accessibility to internal parts without removing.
- b. Automatic valves shall be plastic, spring loaded ball drip type, 150 pounds and threaded ends, designed to close at 6-foot pressure head with positive seal at 3 psi pressure or greater and be open to drain at less than 3 psi pressure.
- c. Manual control valves shall be angle-pattern, globe type with integral union on the discharge (horizontal) end, with a cross on the valve stem for key operation.

## 2.8 BACKFLOW PREVENTERS

Reduced pressure principle assemblies, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCHR-01. Backflow preventers with intermediate atmospheric vent shall be in accordance with ASSE 1012. Reduced pressure principle backflow preventers shall be in accordance with ASSE 1013.

## 2.9 REDUCED PRESSURE TYPE BACKFLOW PREVENTERS

Backflow preventers shall be 150-pound flanged, brass mounted gate valve and strainer, 304 stainless steel or bronze, integral parts. Total pressure drop through complete assembly shall be a maximum of 10 psi at rated flow. Piping shall be red brass pipe and fittings. Strainers shall be bronze or brass construction with gasket caps. Units shall have 200-mesh stainless steel screen elements.

## 2.10 ACCESSORIES AND APPURTENANCES

- a. Valves Keys for Manually Operated Valves - Valve keys shall be 1/2 (12.7 mm)- inch diameter by 3 (914 mm) feet long, tee handles and keyed to fit valves.
- b. Valve Boxes and Covers
- c. Valves Boxes - Valve boxes shall be cast iron, plastic lockable, or precast concrete for each gate valve, manual control valve and remote control valve. Box sizes shall be adjustable for valve used. Shaft diameter of box shall be minimum 5 1/4 (133.4 mm) inches. Cast iron box shall have bituminous coating.

## 2.11 AUTOMATIC CONTROLLERS, ELECTRICAL

- a. Control timing and quantity of water to sprinkler or emitter heads. Use 3 to 60 minutes for sprinkler heads and 0 to 3 hours for emitter heads.
- b. Controller shall conform to the requirements of NEMA ICS 2 with 120 volt single phase service, operating with indicated stations, and

grounded chassis. Enclosure shall conform to NEMA ICS 6 Type 3R, with locking hinged cover, wall mounted. Controller shall be programmed for various schedule by setting switches and dials equipped with the following features: A dial, allowing each station to be scheduled individually as to days of watering; a minute switch for each station with positive increment minute to minute 0.99 minutes, set time within one percent; a switch allowing selected schedules to be repeated after each completion of initial watering schedule and allowing each operation to be scheduled throughout a 24-hour day; a circuit breaker for surge protection; and circuit for a 9-volt rechargeable NiCad battery.

- c. Controllers the product of a manufacturer regularly engaged in the production of turf sprinkler systems and shall be specifically designed for use on irrigation projects and shall be compatible with existing systems on the installation. Controller shall be suitable for operation on the available electrical supply and shall be capable of complete automatic and manual operation of stations, as specified on drawings. Control circuit voltage shall be less than 120 volts and be capable of operating up to two 24-volt AC electric remote control valves per station. Each controller shall have a master switch to disconnect controller from electric supply lines.
- d. Housing: Each controller shall be enclosed in a tamperproof lockable metal housing. Exterior wall-mounted and pedestal-mounted controllers shall be weatherproof. Where more than one controller is installed in an irrigation system, a single-key shall open all cabinets. Two keys for each system shall be furnished.
- e. Programming: Timing for each station shall be viable up to 99 minutes. The programming cycle shall be not less than 14 calendar days. Each station shall be independently times, scheduled, or omitted. Programming shall be changeable without special tools and without disassembling controller.
- f. Charts: A chart showing clearly the areas serviced by each remote control valve shall be provided at each controller.

## 2.12 ELECTRICAL WORK

Wiring and rigid conduit for electrical power shall be in accordance with NFPA 70.

- a. Electric wire from the controller unit to each remote control valve shall be American Wire Gauge (AWG) No. 14 solid copper, Type UF cable, UL approved for direct underground burial.
- b. Color: Wire color shall be continuous over its entire length. Use white for common ground wire. Use easily distinguished colors for other control wires. Spare control wires shall be of a color different from that of the active control wire.
- c. Splices: Use wire connector with waterproof sealant. Wire connector to be of plastic construction consisting of two (2) pieces, one piece which snap locks into the other. A copper crimp sleeve to be provided with connector.

## 2.13 MISCELLANEOUS ITEMS

- a. Service clamps, if any, shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable iron body with cadmium plated straps and nuts. Clamps shall have rubber gasket cemented to the body.
- b. Tapping sleeve(s), if any, of the size(s) indicated for connection to existing main shall be the cast-iron, split-sleeve type with flange on the outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 150 psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets, and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve.

#### 2.14 DRIP IRRIGATION

- a. Polyethylene pipe for drip irrigation shall be of a type specifically manufactured for such use by Bowsmith, or approved equal.
- b. The fittings for polyethylene pipe shall be "compression-type" and be supplied by the pipe manufacturer.
- c. Emitters shall be self-cleaning and operate at pressures between 10 and 50 psi and be capable of delivering between 1.0 and 2.0 gph.
- d. Emitters shall be compatible with the emitter tubing supplied. All emitters shall be supplied by a single manufacturer.
- e. Polyethylene pipe and emitters shall be installed and staked down as recommended by the manufacturer.

#### 2.15 PRESSURE REDUCTION RISER

- a. The pressure reduction riser shall consist of the pressure reducing valve, ball valve, wye strainer, check valve, valve box, and all appurtenances, or as specified on drawings.
- b. The pressure reducing valve shall be a self-contained, single-seat, direct-acting, spring-loaded, diaphragm-actuated type. Valve shall be of all plastic construction, stainless steel body seat, composition seat discs, BUNA "N" diaphragm with nylon insert and stainless steel springs. The valve shall have a maximum working pressure rating of 150 psi and shall be capable of regulating outlet pressure from 5 to 20 psi and have an adjustment screw for setting the pressure. The downstream pressure variance shall not exceed a rate of 0.44 psi for every 10 psi variance (increase or decrease) in upstream or source pressure. The valve shall have an integral "Sharader" pressure test valve.
- c. The valve shall have ½-inch MPT inlet and ¾-inch MHT female outlet.
- d. The threaded in-line spring check valve, if any, shall have a body constructed of type 1 PVC. The valve stem shall be 18-8 stainless steel with BUNA-N poppet seal. The ½ pound spring shall be 18-8 stainless steel. The valve shall have male x female threads, ¾ inch NPT.

- e. The ball valve, if any, shall be construction of Type I PVC (body and handle). The stem seal shall be BUNA "N" with teflon ball seal. The valve shall be rated for a maximum working pressure of 150 micron mesh. The filter shall have an effective filter area of 10 square inches with a gross filter area of 20 square inches. The cartridge housing shall have an integral  $\frac{3}{4}$ - inch ball valve for flushing of the filter without removal of the cartridge.
- f. The wye strainer shall have a filter housing constructed of glass reinforced polypropylene plastic and the removable filter cylinder shall be manufactured of stainless steel and shall be 150 micron mesh. The filter shall have an effective filter area of 10 square inches with a gross filter area of 20 square inches. The cartridge housing shall have an integral  $\frac{3}{4}$ -inch ball valve for flushing of the filter without removal of the cartridge.

#### 2.16 EMITTER ASSEMBLY

- a. The emitters shall be of pressure compensating a continuous flushing type known as a Groove and Flap Short Path Emitter. The case of the emitter shall be made of durable black, plastic material. It shall be resistant to temperature variation, ultraviolet radiation, smog (ozone), common liquid fertilizer and weed spray. The case shall completely encompass the diaphragm, protecting it from potentially harmful environmental factors.
- b. The emitter shall be capable of continuous, self-flushing, clog-free operation with 150 micron mesh minimum filtration for  $\frac{1}{2}$  GPH and 150 mesh for 1 and 2 GPH emitter. The emitter shall be capable of being installed in any position and maintain its given flow characteristics. The emitter shall be non-adjustable and the flow regime shall be maintained by a flexible silicon rubber diaphragm.
- c. The emitter shall function with a system pressure range of 20 psi minimum to 50 psi maximum.
- d. The 2 GPH emitter shall be capable of delivering 2.05 gph at 20 psi, 1.75 gph at 50 psi.
- e. The 1 GPH emitter shall be capable of delivering 1 gph at 20 psi, 1 gph at 50 psi.
- f. The  $\frac{1}{2}$  GPH emitter shall be capable of delivering .5 gph at 20 psi, .45 gph at 50.
- g. The emitter distribution tubing between the emitter and the .580 ID emitter hose shall be .187 inch ID, .250 inch OD. The tubing between the emitter outlet and the point of discharge shall be vinylized. .150 inch ID, .220 inch OD. All tubing shall fit tightly with the corresponding emitter barbs, adapters and discharge outlet.

#### 2.17 FILTERS

The filter housing shall be constructed of glass reinforced polypropylene and the removable filter cylinder shall be manufactured of 150 mesh stainless steel effective filter area of 24 square inches. The cartridge

housing shall have an integral  $\frac{3}{4}$  inch ball valve for flushing, not the filter without removal of the cartridge. Threads shall be 1 inch MPT.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

All planted areas within the Limits Of Construction shall be irrigated. Sprinkler system shall be installed after site grading has been completed. Excavation, trenching, and backfilling for sprinkler system shall be in accordance with the applicable provisions of Site Work for the project. All disturbed areas will be repaired and display positive drainage.

#### 3.2 TRENCHING

Trenching shall be in accordance with SECTION 02316, Excavation, Trenching and Backfilling for Utilities. Trench width shall be 4 inches minimum, or 1-1/2 time diameter of pipe, whichever is wider. Backfill shall be hand tamped over excavation. PVC lateral pipes may be pulled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling. Minimum burial depths equals minimum cover listed above.

Backfill only after lines have been reviewed and tested.

#### 3.3 PIPING SYSTEM

##### 3.3.1 Cover

Underground piping shall be installed as to meet the minimum depth of backfill cover specified below:

Minimum cover (distance from top of pipe or control wire to finish grade):

1. 14-inch over mainline pipe and over electrical conduit.
2. 16-inch over control wire.
3. 10-inch over lateral pipe to sprinklers and bubblers.

##### 3.3.2 Clearances

Minimum horizontal clearances between lines shall be 4 (101.6 mm) inches for pipe 2 (50.8mm) inches and less; 12 (304.8 mm) inches for 2-1/2 (63.5 mm) inches and larger. Minimum vertical clearances between lines shall be 1 (25.4 mm) inch.

##### 3.3.3 Minimum Slope

Minimum slope shall be 6 (152.4 mm) inches per 100 (30.480 M) feet in direction of drain valves.

#### 3.4 SLEEVING AND BORING

Install sleeving at a depth which permits the encased pipe or wiring to remain at the specified burial depth. Extend sleeve ends six inches beyond the edge of the paved surface. Cover pipe ends and mark with stakes. Mark concrete with a chiseled "X" at sleeve end locations. Bore for sleeves under obstructions which cannot be removed. Employ equipment and methods designed for horizontal boring.

### 3.5 PIPING INSTALLATION

#### 3.5.1 Polyvinyl Chloride (PVC) Pipe

- a. Solvent-cemented joints shall conform to the requirements of ASTM D 2855.
- b. Threaded joints shall be full cut with a maximum of three threads remaining exposed on pipe and nipples. Threaded joints shall be made tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.
- c. Piping shall be joined to conform with requirements of ASTM D 2774 or ASTM D 2855, and pipe manufacturer's instructions. Pipe shall be installed in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Pipes shall be installed at temperatures over 40 degrees F.

### 3.6 ASSEMBLING PIPE & FITTINGS

#### 3.6.1 General

1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur. Clean pipe ends.
2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.

#### 3.6.2 Mainline Pipe and Fittings

1. Use only strap-type friction wrenches for threaded plastic pipe.
2. PVC Solvent Weld Pipe:
  - a. Use primer and solvent cement. Join pipe in a manner recommended by the manufacturer and in accordance with accepted industry practices.
  - b. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
  - c. Snake pipe from side to side within the trench.

#### 3.6.3 Lateral Pipe and Fittings

1. Use only strap-type friction wrenches for threaded plastic pipe.
2. PVC Solvent Weld Pipe:
  - a. Use primer and solvent cement. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
  - b. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
  - c. Snake pipe from side to side within the trench.

### 3.6.4 Sprinkler Assembly

1. Flush lateral pipe before installing sprinkler assembly.
2. Install per the installation details at locations shown on the drawings.
3. Locate rotary sprinklers 12 inches from center of sprinkler to adjacent walls, fences, or edges of paved areas.
4. Locate spray sprinklers 3 inches from center of sprinkler to adjacent walls, fences, or edges of paved areas.
5. Set sprinklers perpendicular to the finish grade.
6. Supply appropriate nozzle or adjust are of coverage of each sprinkler for best performance.
7. Adjust the radius of throw of each sprinkler for best performance.

## 3.7 VALVES

### 3.7.1 Manual Valves

Valves shall be installed in a valve box extending from grade to below valve body, with a minimum of 4 (101.6 mm) inches cover measured from finish grade to top of valve stem.

### 3.7.2 Automatic Valves

Valve shall be set plumb in a valve box extending from grade to below valve body, with a minimum of 4 (101.6 mm) inch cover measured from grade to top of valve. Install automatic valves beside sprinkler heads with a valve box.

1. Flush mainline before installation of valve assembly.
2. Install where indicated on the drawings. Wire connectors and waterproof sealant shall be used to connect control wires to remote control valve wires. Install connectors and sealant per the manufacturer's recommendations.
3. Install only one RCV to a valve box. Locate valve box at least 6 inches from and align with nearby walls or edges of paved areas. Group RCV assemblies together where practical. Arrange grouped valve boxes in rectangular patterns.
4. Adjust RCV to regulate the downstream operating pressure.

### 3.7.3 Drain Valves

Entire system shall be manually or automatically drainable. Low points of system shall be equipped with drain valve draining into an excavation containing 1 cubic foot gravel. Gravel shall be covered with building paper then backfilled with excavated material and 6 (152,4 mm) inches of topsoil.

## 3.8 BACKFLOW PREVENTERS

Backflow preventer shall be installed in new connection to existing water

distribution system, between connection and control valves.

### 3.8.1 Backflow Prevention Assembly

Install where indicated on the drawings. Install assembly so that its elevation, orientation, access, and drainage conform to the manufacturer's recommendations and applicable health codes.

### 3.8.2 Reduced Pressure Type

Reduced pressure type shall be installed as follows: Flush pipe lines prior to installing device and protect device by a strainer located upstream. Device shall not be installed in pits or where any part of device could become submerged in standing water.

## 3.9 CONTROL WIRES

1. Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at 10-foot intervals.
2. Control wiring may be pulled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling. Minimum burial depth equals minimum cover previously listed.
3. Provide a 24-inch excess length of wire in an 8-inch diameter loop at each 90 change of direction, at both ends of sleeves, and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop. Coil 24-inch length of wire within each remote control valve box.
4. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted. Install two spare control wires along the entire length of the mainline. Provide a 24-inch length of wire from each end of the spare control wires coiled in the enclosure, and provide a 24-inch length of coiled wire for each spare control wire in a 6-inch round valve box at each distal end of the mainline pipe.
5. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a valve box which contains an irrigation valve assembly, or in a separate 6-inch round valve box. Use same procedure for connection to valves as for in-line splices.
6. Unless noted on plans, install wire parallel with and under PVC mainline pipe.
7. Protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill six inches above the wiring.

## 3.10 IRRIGATION CONTROLLER UNIT

1. The location of the controller unit as depicted on the drawings is approximate; the AF Representative will determine the exact site location during sprinkler layout review.
2. Lightning protection: Drive an 8-foot copper-clad grounding rod into the soil. If rock prevents driving, bury at least four feet deep. Use one rod for each controller. Connect controller to grounding rod with AWG No. 10 solid conductor copper wire. Secure wire to grounding rod

with brass or bronze clamp. Locate the connection in a separate valve box.

3. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with the identification number (see drawings) of the remote control valve to which the control wire is connected.

4. Connect control wires to the corresponding controller terminal.

### 3.11 BACKFILL

#### 3.11.1 Minimum Cover

Depth of cover shall be 12 (304.8 mm) inches for 1-1/4 (31.8 mm) inch pipe or smaller; and 12 (304.8 mm) inches for low-voltage wires. Remainder of trench or pipe cover shall be filled to within 3 (76.2 mm) inches of top-with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

### 3.12 IRRIGATION SYSTEM TO BE INSTALLED PRIOR TO PLANTING MATERIALS (UNLESS OTHERWISE DIRECTED)

#### 3.12.1 Adjustment

After grading, seeding and rolling of planted areas, sprinkler heads shall be adjusted flush with finished grade. Adjustments shall be made by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

#### 3.12.2 Cleaning of Piping

Prior to the hydrostatic and operation tests, the interior of the pipe shall be flushed with clean water until pipe is free of all foreign materials. Flushing and cleaning out of system pipe, valves, and components shall not be considered completed until witnessed and accepted by Contracting Officer.

#### 3.12.3 Field Tests

All instruments, equipment, facilities, and labor required to conduct the tests shall be provided by Contractor.

#### 3.12.4 Hydrostatic Pressure Test

1. Notify the AF Representative three days in advance of testing.
2. Pipelines jointed with rubber gaskets or threaded connections may be subjected to a pressure test at any time after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints shall be allowed to cure at least 24 hours before testing.
3. Subsections of mainline pipe may be tested independently, subject to the review of the AF Representative.
4. Furnish clean, clear water, pumps, labor, fittings, and equipment necessary to conduct tests or retest.

5. Subject mainline pipe to a hydrostatic pressure equal to 60 psi for two hours. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.

#### 3.12.5 Coverage Test

- a. Activate each remote control valve in sequence. The AF Representative will visually observe water application patterns.
- b. Adjust or move system components to correct coverage deficiencies. Repeat the test until the system passes test.
- c. Cement or caulking to seal leaks is prohibited.

#### 3.12.6 Operation Test

At conclusion of pressure test, sprinkler heads or emitter heads, quick coupling assemblies, and hose valves shall be installed and entire system tested for operation under normal operating pressure. Operation test consists of the system operating through at least one complete programmed cycle for all areas to be sprinkled.

#### 3.13 FIELD TRAINING

A field training course shall be provided for designed operating and maintenance staff members. Training shall be provided for a total period of 1 hour to normal working time and shall start after the system is functionally complete prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.

-- End of Section --

## SECTION 03101A

FORMWORK FOR CONCRETE  
09/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 347R (1994; R 1999) Guide to Formwork for Concrete

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M (2000) Making and Curing Concrete Test Specimens in the Field

ASTM C 39/C 39M (1999) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 1077 (1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

## U.S. DEPARTMENT OF COMMERCE (DOC)

PS-1 (1996) Voluntary Product Standard - Construction and Industrial Plywood

## 1.2 DESIGN REQUIREMENTS

The design, engineering, and construction of the formwork shall be the responsibility of the Contractor. The formwork shall be designed for anticipated live and dead loads and shall comply with the tolerances specified in Section 03300 CAST-IN-PLACE CONCRETE, paragraph CONSTRUCTION TOLERANCES. However, for surfaces with an ACI Class A surface designation, the allowable deflection for facing material between studs, for studs between walers and walers between bracing shall be limited to 0.0025 times the span. The formwork shall be designed as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. The adequacy of formwork design and construction shall be monitored prior to and during concrete placement as part of the Contractor's approved Quality Control Plan.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Materials

Manufacturer's literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, and form coating.

SD-06 Test Reports

Inspection

The Contractor shall submit field inspection reports for concrete forms and embedded items.

Formwork Not Supporting Weight of Concrete.

If forms are to be removed in less than 24 hours on formwork not supporting the weight of concrete, the evaluation and results of the control cylinder tests shall be submitted to and approved before the forms are removed.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Forms and Form Liners

Forms and form liners shall be fabricated with facing materials that will produce a finish meeting the specified irregularities in formed surface requirements as defined in ACI 347R. Forms and form liners shall be fabricated with facing materials as specified below.

2.1.1.1 Class "B" Finish

This class of finish shall apply to all exposed to view concrete surfaces. The form facing material shall be composed of tongue-and-groove or shiplap lumber, plywood conforming to PS-1, Grade B-B concrete form, tempered concrete form hard board or steel. Steel lining on wood sheathing will not be permitted.

2.1.1.2 Class "C" Finish

This class of finish shall apply to all surfaces not receiving a class B or class D finish. The form facing may be either tongue-and-groove lumber, plywood, concrete form hard board or steel. Wood form facing for curved or warped surfaces shall be composed of splines of lumber which can be bent to the required shape without splitting or cracking.

2.1.1.3 Class "D" Finish

This class of finish shall apply to concrete footings. The form facing may be of wood or steel.

2.1.2 Form Coating

Form coating shall be commercial formulation that will not bond with,

stain, cause deterioration, or any other damage to concrete surfaces. The coating shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, the Contractor shall follow the recommendation of the form coating manufacturer.

## 2.2 ACCESSORIES

Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2 inches from any concrete surface either exposed to view or exposed to water. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Form Construction

Forms shall be constructed true to the structural design and required alignment. The form surface and joints shall be mortar tight and supported to achieve safe performance during construction, concrete placement, and form removal. The Contractor shall continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface class or classes specified in paragraph FORMS AND FORM LINERS and tolerances specified in paragraph DESIGN REQUIREMENTS. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse.

#### 3.1.2 Chamfering

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated twelve inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

#### 3.1.3 Coating

Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that, in cold

weather when freezing temperatures are anticipated, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

### 3.2 FORM REMOVAL

Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the minimum time requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Form removal shall be scheduled so that all necessary repairs can be performed as specified in Section 03300, paragraph 3.11. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C 31/C 31M and ASTM C 39/C 39M at the expense of the Contractor by an independent laboratory that complies with ASTM C 1077 and shall be tested within 4 hours after removal from the site.

#### 3.2.1 Formwork Not Supporting Weight of Concrete

Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed.

#### 3.2.2 Formwork Supporting Weight of Concrete

Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, forms shall be left in place until control concrete test cylinders indicate evidence the concrete has attained at least 75 percent of the compressive strength required for the structure.

### 3.3 INSPECTION

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

-- End of Section --

## SECTION 03150A

EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS  
05/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1995) Basic Hardboard

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 919 (1984; R 1998) Use of Sealants in Acoustical Applications

ASTM C 920 (1998) Elastomeric Joint Sealants

ASTM D 471 (1998el) Rubber Property - Effect of Liquids

ASTM D 1190 (1997) Concrete Joint Sealer, Hot-Applied Elastic Type

ASTM D 1191 (1984; R 1994el) Concrete Joint Sealers

ASTM D 1751 (1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 2628 (1991; R 1998) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

ASTM D 5249 (1995) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

## U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513 (1974) Corps of Engineers Specifications for Rubber Waterstops

COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Waterstops

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

### SD-03 Product Data

#### Preformed Expansion Joint Filler Sealant Waterstops

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops.

Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.

### SD-07 Certificates

#### Preformed Expansion Joint Filler Sealant Waterstops

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified.

## 1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

## PART 2 PRODUCTS

### 2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 1/8 inch thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

### 2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 1/4 inch thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

### 2.3 SEALANT

Joint sealant shall conform to the following:

#### 2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

#### 2.3.2 Hot-Poured Type

ASTM D 1190 tested in accordance with ASTM D 1191.

#### 2.3.3 Field-Molded Type

ASTM C 920, Type M for horizontal joints or Type NS for vertical joints, Class 25, and Use NT. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber.

### 2.4 WATERSTOPS

Intersection and change of direction waterstops shall be shop fabricated.

#### 2.4.1 Non-Metallic Materials`

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops shall conform to ASTM D 471.

## PART 3 EXECUTION

### 3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

#### 3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8 inch wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 1 inch.

##### 3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the

joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. True alignment of the strips shall be maintained during insertion.

#### 3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling, usually within 24 hours of the start of pouring concrete. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

#### 3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8 inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

#### 3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

##### 3.1.3.1 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C 919 shall be followed. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

#### 3.2 WATERSTOPS, INSTALLATION AND SPLICES

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Splices shall be made by certified trained personnel using approved equipment and procedures.

### 3.2.1 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependant), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice.

#### 3.2.1.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for TPE-R shall be as specified for PVC.

#### 3.2.1.2 Polyvinyl Chloride Waterstop

Splices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

#### 3.2.1.3 Quality Assurance

Edge welding will not be permitted. Centerbulbs shall be compressed or closed when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 1/16 inch. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 1/2 inch in 10 feet. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9) Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

### 3.3 CONSTRUCTION JOINTS

Construction joints are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE except that construction joints coinciding with expansion and contraction joints shall be treated as expansion or contraction joints as applicable.

-- End of Section --



## SECTION 03200A

CONCRETE REINFORCEMENT  
09/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 318/318R (1995) Building Code Requirements for Structural Concrete and Commentary

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1999) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 184/A 184M (1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A 185 (1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 615/A 615M (1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 675/A 675M (1990a; R 1995e1) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

## CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1 (1996) Manual of Standard Practice

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcement; G

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

## SD-07 Certificates

## Reinforcing Steel;

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

## 1.3 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

## PART 2 PRODUCTS

## 2.1 DOWELS

Dowels shall conform to ASTM A 675/A 675M, Grade 80. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

## 2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M.

## 2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M grade and sizes as indicated.

## 2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185. Welded wire fabric shall be provided in flat sheets.

## 2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

## 2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

## PART 3 EXECUTION

### 3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

#### 3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

#### 3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 2 inches maximum. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

### 3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports. Hooking of welded wire fabric is not permitted.

### 3.3 DOWEL INSTALLATION

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement.

One end of dowels shall be coated with a bond breaker.

-- End of Section --

## SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE  
11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988; R 1997) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 182	(1991; R 1996) Burlap Cloth Made from Jute or Kenaf
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1017/C 1017M	(1998) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143/C 143M	(2000) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 173	(1994ael) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2000) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997el) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2000) Air-Entraining Admixtures for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2000el) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1999ael) Concrete Aggregates
ASTM C 39/C 39M	(2001) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(1999ael) Chemical Admixtures for Concrete
ASTM C 552	(2000) Cellular Glass Thermal Insulation
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	(2000a) Blended Hydraulic Cements
ASTM C 618	(2000) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1997) Grout Fluidifier for Preplaced-Aggregate Concrete

ASTM C 94/C 94M	(2000e2) Ready-Mixed Concrete
ASTM C 940	(1998a) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 989	(1999) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM E 1155	(1996) Determining Floor Flatness and Levelness Using the F-Number System
ASTM E 96	(2000) Water Vapor Transmission of Materials

## NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices
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## NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards \n/c\$\X
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities
NRMCA TMMB 100	(1994) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards

## U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

## 1.2 LUMP SUM CONTRACT

Under this type of contract concrete items will be paid for by lump sum and will not be measured. The work covered by these items consists of furnishing all concrete materials, reinforcement, miscellaneous embedded materials, and equipment, and performing all labor for the forming, manufacture, transporting, placing, finishing, curing, and protection of concrete in these structures.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-03 Product Data

#### Mixture Proportions

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

### SD-06 Test Reports

#### Testing and Inspection for Contractor Quality Control

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project. In addition to required number of submittals, send one copy of all test reports directly to the Contracting Officer for information and record purposes.

### SD-07 Certificates

#### Qualifications

Written documentation for Contractor Quality Control personnel.

## 1.4 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the

following grades or shall have written evidence of having completed similar qualification programs:

- Concrete Field Testing Technician, Grade I
- Concrete Laboratory Testing Technician, Grade I or II
- Concrete Construction Inspector, Level II

Concrete Transportation Construction Inspector or Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI), Building Official and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

1.5 FIELD TEST PANELS

Field test panels shall be constructed prior to beginning of work using the materials and procedures proposed for use on the job, to demonstrate the results to be attained. The quality and appearance of each panel shall be subject to the approval of the Contracting Officer, and, if not judged satisfactory, additional panels shall be constructed until approval is attained. Formed or finished surfaces in the completed structure shall match the quality and appearance of the approved field example.

1.5.1 Slab Panels

A slab panel at least 4 feet by 5 feet and 4 inches thick shall be constructed to establish the acceptable criteria for a broom finish.

1.6 GENERAL REQUIREMENTS

1.6.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

1.6.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R	This Section
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Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish
Very Flat	Same. Use only with F-system

Levelness tolerance shall not apply where design requires floors to be

sloped to drains or sloped for other reasons.

#### 1.6.1.2 Floors by the F-Number System

The flatness and levelness of floors shall be carefully controlled and the tolerances shall be measured by the F-Number system of Paragraph 4.5.6 and 4.5.6.1 of ACI 117/117R. The Contractor shall furnish an approved floor profilograph or other equipment capable of measuring the floor flatness (FF) number and the floor levelness (FL) number in accordance with ASTM E 1155. The Contractor shall perform the tolerance measurements within 72 hours after floor slab construction while being observed by the Contracting Officer. The tolerances of surfaces beyond the limits of ASTM E 1155 (the areas within 24 inches of embedments and construction joints) shall be acceptable to the Contracting Officer. Tolerances of the following areas shall meet the requirements for the listed surfaces as specified in paragraphs 4.5.6 and 4.5.6.1 of ACI 117/117R.

#### 1.6.2 Strength Requirements and w/c Ratio

##### 1.6.2.1 Strength Requirements

Specified compressive strength (f'c) shall be as follows:

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
4000 psi at 28 days	All concrete except foundations.
3000 psi at 28 days	Concrete foundations.

Concrete slabs on-grade shall have a 28-day flexural strength of 650 psi. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement. Compressive strength shall be determined in accordance with ASTM C 39/C 39M. Flexural strength shall be determined in accordance with ASTM C 78.

- a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (6 by 12 inch cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.
- b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42/C 42M. At

least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient.

The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement.

Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

- c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.
- d. Evaluation of Concrete Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 78. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified flexural strength and no individual test result falls below the specified flexural strength by more than 50 psi. A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

#### 1.6.3 Air Entrainment

All normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 3/4 inch or smaller it shall be between 4.5 and 7.5 percent. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231.

#### 1.6.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143/C 143M.

Structural Element	Slump	
Minimum	Maximum	
Walls, columns and beams	2 in.	4 in.
Foundation walls, substructure walls, footings, slabs	1 in.	3 in.
Any structural concrete approved for placement by pumping:		
At pump	2 in.	6 in.
At discharge of line	1 in.	4 in.

When use of a plasticizing admixture conforming to ASTM C 1017/C 1017M or when a Type F or G high range water reducing admixture conforming to ASTM C 494/C 494M is permitted to increase the slump of concrete, concrete shall have a slump of 2 to 4 inches before the admixture is added and a maximum slump of 8 inches at the point of delivery after the admixture is added.

#### 1.6.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 90 degrees F.

When the ambient temperature during placing is 40 degrees F or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 55 and 75 degrees F.

#### 1.6.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

#### 1.6.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

### 1.7 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

#### 1.7.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M. Samples of all

materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in subparagraph Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use.

No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192/C 192M. They shall be tested at 7 and 28 days in accordance with ASTM C 39/C 39M. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

#### 1.7.2 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength ( $f'_{cr}$ ) exceeding the specified compressive strength ( $f'_c$ ) by the amount indicated below. This required average compressive strength,  $f'_{cr}$ , will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below  $f'_{cr}$  during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day  $f'_{cr}$ , the mixture shall be adjusted, as approved, to bring the daily average back up to  $f'_{cr}$ . During production, the required  $f'_{cr}$  shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

##### 1.7.2.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified

strength or strengths ( $f'c$ ) within 1,000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength  $f'cr$  used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'cr = f'c + 1.34S \text{ where units are in psi}$$

$$f'cr = f'c + 2.33S - 500 \text{ where units are in psi}$$

Where  $S$  = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

#### 1.7.2.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength  $f'cr$  shall be determined as follows:

- a. If the specified compressive strength  $f'c$  is less than 3,000 psi,

$$f'cr = f'c + 1000 \text{ psi}$$

- b. If the specified compressive strength  $f'c$  is 3,000 to 5,000 psi,

$$f'cr = f'c + 1,200 \text{ psi}$$

- c. If the specified compressive strength  $f'c$  is over 5,000 psi,

$$f'cr = f'c + 1,400 \text{ psi}$$

#### 1.8 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not

be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

#### 1.9 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

##### 1.9.1 Materials

The Government will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

##### 1.9.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

##### 1.9.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

##### 1.9.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

#### PART 2 PRODUCTS

##### 2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement, portland-pozzolan cement, portland blast-furnace slag cement, or portland cement in combination with pozzolan or ground granulated blast furnace slag and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

##### 2.1.1 Portland Cement

ASTM C 150, Type I with a maximum 15 percent amount of tricalcium aluminate, or Type II .

### 2.1.2 Blended Cements

ASTM C 595, Type IP (MS) or IS (MS).

### 2.1.3 Pozzolan (Fly Ash)

ASTM C 618, Class C with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. If pozzolan is used, it shall never be less than 15 percent nor more than 35 percent by weight of the total cementitious material. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

### 2.1.4 Ground Granulated Blast-Furnace (GGBF) Slag

ASTM C 989, Grade 120.

## 2.2 AGGREGATES

Aggregates shall conform to the following.

### 2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

### 2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S, size designation 57.

## 2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

### 2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

### 2.3.2 Accelerating Admixture

ASTM C 494/C 494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

### 2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494/C 494M, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

### 2.3.4 High-Range Water Reducer

ASTM C 494/C 494M, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

### 2.3.5 Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

### 2.3.6 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017/C 1017M, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

## 2.4 CURING MATERIALS

### 2.4.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

### 2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

### 2.4.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

## 2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

## 2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, Grade AB, and shall be a commercial formulation suitable for the proposed application.

## 2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of 55 percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland cement paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the No. 30 sieve to particles passing the No. 8 sieve.

## 2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C

1059.

## 2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

## 2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

## 2.11 FLOOR HARDENER

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

## 2.12 PERIMETER INSULATION

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV. The Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

## 2.13 VAPOR RETARDER

Vapor retarder shall be polyethylene sheeting with a minimum thickness of 6 mils or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

## 2.14 JOINT MATERIALS

### 2.14.1 Joint Fillers, Sealers, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1751. Materials for waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 07900 JOINT SEALING.

### 2.14.2 Contraction Joints in Slabs

Sawable type contraction joint inserts shall conform to COE CRD-C 540. Nonsawable joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of Section 3.4 "Resistance to Sawing". Plastic inserts shall be polyvinyl chloride conforming to the materials requirements of COE CRD-C 572.

## PART 3 EXECUTION

### 3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

### 3.1.1 Foundations

#### 3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

#### 3.1.1.2 Excavated Surfaces in Lieu of Forms

Concrete for footings may be placed directly against the soil provided the earth has been carefully trimmed, is uniform and stable, and meets the compaction requirements of Section 02315 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. The concrete shall be placed without becoming contaminated by loose material, and the outline of the concrete shall be within the specified tolerances.

### 3.1.2 Previously Placed Concrete

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next horizontal lift by cleaning the construction joint surface with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Concrete at the side of vertical construction joints shall be prepared as approved by the Contracting Officer. Air-water cutting shall not be used on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean surfaces of well bonded coarse aggregate are exposed and make up at least 10-percent of the surface area, distributed uniformly throughout the surface. The edges of the coarse aggregate shall not be undercut. The surface of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing fresh concrete. The surface shall be washed completely clean as the last operation prior to placing the next lift. For heavy duty floors and two-course floors a thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the topping placing. The grout shall be a 1:1 mixture of portland cement and sand passing the No. 8 sieve. The topping concrete shall be deposited before the grout coat has had time to stiffen.

### 3.1.2.1 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

### 3.1.3 Vapor Retarder

Vapor retarder shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of 12 inches. Torn, punctured, or damaged vapor retarder material shall be removed and new vapor retarder shall be provided prior to placing concrete.

For minor repairs, patches may be made using laps of at least 12 inches. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 2 inches wide and compatible with the membrane. Vapor retarder shall be placed directly on underlying subgrade, base course, or capillary water barrier. Concrete placement shall be controlled so as to prevent damage to the vapor retarder, or any covering sand.

### 3.1.4 Perimeter Insulation

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

### 3.1.5 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 1 foot of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

## 3.2 CONCRETE PRODUCTION

### 3.2.1 Batching, Mixing, and Transporting Concrete

Concrete shall either be batched and mixed onsite or shall be furnished from a ready-mixed concrete plant. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94/C 94M, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall conform to the following subparagraphs.

#### 3.2.1.1 General

The batching plant shall be located off site close to the project. The

batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

#### 3.2.1.2 Batching Equipment

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. If both portland cement and other cementitious material are used, they may be batched cumulatively, provided that the portland cement is batched first. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

#### 3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the specified frequency in the presence of a Government inspector. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

## 3.2.1.4 Batching Tolerances

## (A) Tolerances with Weighing Equipment

MATERIAL	PERCENT OF REQUIRED WEIGHT
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

## (B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

MATERIAL	PERCENT OF REQUIRED MATERIAL
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

## 3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

## 3.2.1.6 Concrete Mixers

Mixers shall be stationary mixers or truck mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

## 3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting, horizontal-shaft, or vertical-shaft type, or shall be pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94/C 94M applicable to central-mixed concrete.

## 3.2.1.8 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94/C 94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped

with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Water shall not be added at the placing site unless specifically approved; and in no case shall it exceed the specified w/c. Any such water shall be injected at the base of the mixer, not at the discharge end.

### 3.3 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers, agitators, nonagitating transporting equipment conforming to NRMCA TMMB 100 or by approved pumping equipment.

### 3.4 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

#### 3.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

#### 3.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

#### 3.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94/C 94M. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

#### 3.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar

equipment will not be permitted for conveying concrete.

#### 3.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches.

The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

#### 3.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

### 3.5 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

#### 3.5.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service

becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

### 3.5.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.025 inch, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

### 3.5.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. The temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494/C 494M, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

### 3.5.4 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 85 degrees F, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 120 degrees F.

Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

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Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	90 F
40-60	85 F
Less than 40	80 F

### 3.5.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

### 3.5.6 Placing Concrete in Congested Areas

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

### 3.5.7 Placing Flowable Concrete

If a plasticizing admixture conforming to ASTM C 1017/C 1017M is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

### 3.6 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 2 inches clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and vertical surfaces shall consist of 30 pound asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07900 JOINT SEALING.

#### 3.6.1 Construction Joints

Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 1 inch-square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

#### 3.6.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by use of rigid inserts impressed in the concrete during placing operations or sawing a continuous slot with a concrete saw.

Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 1/8 and 3/16 inch wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete, but in no case shall cutting exceed 24 hours from the beginning of concrete placement. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

### 3.6.3 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

### 3.6.4 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1/8 inch in 12 inches. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

## 3.7 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

### 3.7.1 Class A Finish and Class B Finish

Class B finish is required on all exposed to view concrete surfaces. Fins, ravelings, and loose material shall be removed, all surface defects over 1/2 inch in diameter or more than 1/2 inch deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 1/2 inch in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep. The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

### 3.7.2 Class C and Class D Finish

Class C finish is required where Class B or D finish is not required. Class D finish is required for footings. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 1/2 inch deep or more than 2 inches in diameter shall be repaired. Defects more than 2 inches in diameter shall be cut back to sound concrete, but in all cases at least 1 inch deep.

## 3.8 REPAIRS

### 3.8.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 4 inches shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

### 3.8.2 Repair of Major Defects

Major defects will be considered to be those more than 1/2 inch deep or, for Class A and B finishes, more than 1/2 inch in diameter and, for Class C and D finishes, more than 2 inches in diameter. Also included are any defects of any kind whose depth is over 4 inches or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

#### 3.8.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 2 inches on all sides. All such defective areas greater than 12 square inches shall be outlined by saw cuts at least 1 inch deep. Defective areas less than 12 square inches shall be outlined by a 1 inch deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

#### 3.8.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 6 inches deep and also have an average diameter at the surface more than 18 inches or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening.

A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

### 3.9 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

#### 3.9.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 50 degrees F. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

#### 3.9.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

#### 3.9.3 Floated Finish

Slabs to receive more than a rough slab finish shall next be given a wood float finish. Use for exterior slabs where not otherwise specified. The

screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 1/4 inch and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Care shall be taken to prevent over-finishing or incorporating water into the surface.

#### 3.9.4 Troweled Finish

Surfaces exposed to view and surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, or other thin film-finish coating system shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 2 times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

#### 3.9.5 Broomed Finish

Exterior concrete platforms, slabs, steps, ramps, and elsewhere as indicated shall be given a broomed finish. After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a coarse fiber push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles. The Contractor shall provide a sample panel of the broomed finish for approval by the Contracting Officer. The sample panel will establish the acceptable criteria upon which all broomed finishes shall match.

#### 3.10 FLOOR HARDENER

All interior exposed concrete floors not receiving a floor covering shall be treated with floor hardener. Floor hardener shall be applied after the concrete has been cured and then air dried for 14 days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, one pound of the silocofluoride shall be dissolved in one gallon of water. For subsequent applications, the solution shall be two pounds of silicofluoride to each gallon of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying

silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

### 3.11 EXTERIOR SLAB AND RELATED ITEMS

#### 3.11.1 Pavements

Pavements shall be constructed where shown on the drawings. After forms are set and underlying material prepared as specified, the concrete shall be placed uniformly throughout the area and thoroughly vibrated. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The entire surface shall be tamped with the strike off, or consolidated with a vibrating screed, and this operation continued until the required compaction and reduction of internal and surface voids are accomplished. Care shall be taken to prevent bringing excess paste to the surface. Immediately following the final consolidation of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces. After finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled cutting straightedges. Straightedges shall be 12 feet in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be equipped with a handle 3 feet longer than one-half the width of the pavement. The surface shall then be tested for trueness with a 12 foot straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is true. Before the surface sheen has disappeared and well before the concrete becomes nonplastic, the surface of the pavement shall be given a nonslip sandy surface texture by use of a burlap drag. A strip of clean, wet burlap from 3 to 5 feet wide and 2 feet longer than the pavement width shall be carefully pulled across the surface. Edges and joints shall be rounded with an edger having a radius of 1/8 inch. Curing shall be as specified.

#### 3.11.2 Sidewalks

For sidewalks refer to specification section 02770a, "Concrete Sidewalks and Curbs and Gutters."

#### 3.11.3 Curbs and Gutters

For curbs and gutters refer to specification section 02770a, "Concrete Sidewalks and Curbs and Gutters."

#### 3.11.4 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

### 3.12 CURING AND PROTECTION

#### 3.12.1 General

Concrete shall be cured by an approved method for the period of time given below:

All concrete 7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded.

Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

#### 3.12.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

#### 3.12.3 Membrane Forming Curing Compounds

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other

concrete to be bonded, or on any exposed to view concrete surfaces. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

#### 3.12.4 Impervious Sheeting

Impervious-sheet curing shall only be used on horizontal or nearly horizontal surfaces. Surfaces shall be thoroughly wetted and be completely covered with the sheeting. Sheeting shall be at least 18 inches wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

#### 3.12.5 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.

#### 3.12.6 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 32 degrees F the temperature of the concrete shall be maintained above 40 degrees F for the first seven days after placing. During the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by suitable temperature measuring devices furnished by the Government, as required, and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the

Contractor as directed.

### 3.13 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 3/4 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed. Nonshrink grout shall be used for column base plates.

#### 3.13.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

#### 3.13.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

##### 3.13.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

##### 3.13.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 1 inch and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

### 3.14 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per quarter thereafter for conformance with ASTM C 1077.

#### 3.14.1 Grading and Corrective Action

##### 3.14.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

##### 3.14.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

##### 3.14.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after

the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

#### 3.14.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

#### 3.14.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during each day's plant operation.

#### 3.14.5 Concrete Mixture

- a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set

1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

- b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.
- c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143/C 143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 1/2 inch below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

- d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.
- e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064/C 1064M. The temperature shall be reported along with the compressive strength data.
- f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 500 cubic yards or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R. Samples of concrete that is conveyed by belt conveyors or pumps, as specified in the paragraph titled "Conveying Concrete on Site," shall be taken at the discharge end of the conveying equipment.

#### 3.14.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

### 3.14.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

### 3.14.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

### 3.14.9 Curing Inspection

- a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.
- b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.
- c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square feet per gallon, and shall note whether or not coverage is uniform.
- d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.
- e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and

the tightness of the laps and tapes shall be noted and recorded.

- f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

#### 3.14.10 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

#### 3.14.11 Mixer Uniformity

- a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M.
- b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.
- c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

#### 3.14.12 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

## SECTION 03413A

PRECAST ARCHITECTURAL CONCRETE  
05/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1998) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI SP-66	(1994) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement
ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 416/A 416M	(1997) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM C 494	(1998) Chemical Admixtures for Concrete
ASTM C 1017	(1997) Chemical Admixtures for Use in Producing Flowing Concrete

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structured Welding Code - Steel
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## PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1985) Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products
PCI MNL-117	(1996) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products
PCI MNL-122	(1989) Architectural Precast Concrete

## 1.2 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer certified under the PCI Plant Certification Program. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. Precast work shall be coordinated with the work of other trades.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Architectural Concrete System; G, AE

Detail drawings showing details in accordance with ACI SP-66 and ACI 318/318R, including installation details. Detail drawings shall indicate separate identification marks for each different precast unit, location of units in the work, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, blocking points for units stored at the precast concrete plant or at the jobsite, lifting points and special handling instructions in sufficient detail to cover manufacture, handling, and erection.

### SD-03 Product Data

#### Calculations; G, AE

Design calculations, prior to the manufacture of any precast architectural concrete units for the project.

#### Mix Design; G, AE

A statement giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, prior to commencing operations. The statement shall be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. No substitutions shall be made without additional tests to verify that the concrete properties are satisfactory.

#### Manufacturer's Qualifications

A statement giving the qualifications of the precast concrete manufacturer and of the installers, prior to commencing operations.

### SD-04 Samples

#### Precast Concrete Units; G, AE

Two 12 by 12 by 2 inch samples of each type of precast unit finish required for the project. Samples shall show matrix color, surface color, surface texture, and panel back finish. A full-size mock-up, maintained at the precast concrete manufacturer's plant until approval by the Contracting Officer for removal or incorporating in the project. The mock-up shall be used to establish quality and acceptance of precast units to be used on the project, and shall consist of three or more units, showing the exterior finish (matrix color, surface color, surface texture), panel back finish, edge treatment, joint treatment, reinforcement, anchorage insert, lifting inserts, and other accessories. Mockup shall also include typical joints, including exterior corner joints and joints between units.

#### SD-06 Test Reports

##### Materials

Certified copies of test reports including all test data and all test results. Tests for compressive strength of concrete shall be performed by an approved independent commercial testing laboratory, except that compressive strength tests for initial prestress may be performed in the manufacturer's plant laboratory.

#### 1.4 DESIGN

##### 1.4.1 Standards and Loads

Precast unit design shall conform to ACI 318/318R and PCI MNL-122. Design loads for precast concrete shall be as indicated on the drawings. A differential temperature of 160 degrees F, between interior and exterior faces of the units, shall be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection shall be accounted for in the design.

##### 1.4.2 Connections

Connection of units to other members, or to other units shall be of the type and configuration indicated. The design and sizing of connections for all design loads shall be by the Contractor.

##### 1.4.3 Concrete Strength

Precast concrete units shall have a 28-day compressive strength of 5000 psi.

##### 1.4.4 Concrete Proportion

Selection of proportions for concrete shall be based on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. The concrete proportion shall be developed using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Calcium chloride shall not be used in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive shall not be used in prestressed concrete.

##### 1.4.5 Calculations

Calculations for design of members and connections not shown shall be made by a professional engineer experienced in the design of precast architectural concrete. Calculation shall include the analysis of member for lifting stresses and the sizing of the lifting inserts.

#### 1.5 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Precast units temporarily stored at the manufacturer's plant shall be protected from damage in accordance with PCI MNL-116, PCI MNL-117, and PCI MNL-122. Immediately prior to shipment to the jobsite, all precast concrete units shall be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality shall include, but shall not necessarily be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. All defective precast concrete units shall be replaced or repaired as approved by the Contracting Officer.

#### 1.6 HANDLING AND STORAGE

Precast units shall be delivered to the site in accordance with delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite all precast units shall be inspected for quality as specified above. If the precast units cannot be unloaded and placed directly into the work, they shall be stored onsite, off the ground and protected from weather, marring, or overload. Precast units shall be handled in accordance with manufacturer's instructions.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Except as otherwise specified, material shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and Section 03200 CONCRETE REINFORCEMENT.

##### 2.1.1 Aggregates

Aggregates shall be the following:

Fine aggregate + M 798 lbs. Best Quarry N.C. or equal per yard.

Course aggregate + M 2008 lbs. Best Quarry N.C. or equal per yard.

##### 2.1.2 Reinforcing Steel

Reinforcing steel shall be galvanized if clearance to an exterior face is 1 inch or less.

##### 2.1.3 Prestressing Strands

Prestressing strands shall conform to ASTM A 416/A 416M.

##### 2.1.4 Tie Wire

Tie wire shall be soft monel or 18-8 stainless steel.

##### 2.1.5 Inserts

Inserts shall be manufacturer's standard, suited for the application.

### 2.1.6 Plates, Angles, Anchors and Embedments

Material shall be as specified in PCI MNL-117. Steel items, other than stainless, shall be coated with a rust-inhibiting paint or shall be hot-dip galvanized. Steel items, including items embedded in concrete, shall be either stainless steel or hot dip galvanized steel.

### 2.1.7 Form Release Agent

Release agent shall be manufacturer's standard nonstaining type.

### 2.1.8 Admixtures

Admixtures shall conform to ASTM C 494. Plasticizing admixture, if used, shall conform to ASTM C 1017.

### 2.1.9 Mix Design

Mix design shall be Buff Best M by P&D Precast, Inc. or equal.

## 2.2 PRECAST CONCRETE UNITS

Precast concrete units shall be manufactured and cured in accordance with the applicable provisions of PCI MNL-116 and PCI MNL-117. Units shall be manufactured within the allowable tolerances given in PCI MNL-116, PCI MNL-117 and PCI MNL-122.

### 2.2.1 Formwork

Forms shall be steel of adequate thickness, braced, stiffened, anchored and aligned to produce precast architectural concrete units within required dimensional tolerances. Forms shall be sufficiently rigid to provide dimensional stability during handling and concrete placement and consolidation. Fiberglass-reinforced plastic, plastic coated wood, elastomeric or other nonabsorptive material shall be used for making tight joints and rustication pieces.

### 2.2.2 Reinforcement

Fabrication and placement of reinforcement shall conform to the details shown on the approved detail drawings and PCI MNL-116 and PCI MNL-117.

### 2.2.3 Embedded Accessories

Anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units shall be furnished and installed in accordance with the approved detail drawings. Embedded items shall be accurately positioned in their designed location, and shall have sufficient anchorage and embedment to satisfy design requirements.

### 2.2.4 Stripping

Precast concrete units shall not be removed from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

### 2.2.5 Identification

Each precast concrete unit shall be marked to correspond to the identification marks for each different precast unit shown on the detail drawings.

#### 2.2.6 Finishes

##### 2.2.6.1 Exposed Surfaces

Surfaces of precast units exposed to view or surfaces indicated to be finished shall be finished as follows: Acid etch.

##### 2.2.6.2 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished shall be finished in accordance with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### PART 3 EXECUTION

#### 3.1 ERECTION

Precast units shall be erected in accordance with the detail drawings and without damage to other units or to adjacent members. Units shall be set true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances shall be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges shall be placed as required to maintain correct alignment. After final attachment, precast units shall be grouted as shown. After erection, welds and abraded surfaces of steel shall be cleaned and touched-up with a zinc-rich paint. Welds shall be made by a certified welder in accordance with the manufacturer's erection drawings. Pickup points, boxouts, inserts, and similar items shall be finished to match adjacent areas after erection. Erection of precast units shall be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders shall be in accordance with AWS D1.1.

#### 3.2 JOINT SEALING

Joint sealing shall be as specified in Section 07900 JOINT SEALING.

#### 3.3 CLEANING

Not sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast concrete discolored during erection shall be cleaned to remove dirt and stains by dry scrubbing with a stiff fiber brush, wetting the surface and vigorous scrubbing of the finish with a stiff fiber brush followed by additional washing, or by chemical cleaning compounds such as detergents or other commercial cleaners. Commercial cleaners shall be used in accordance with the manufacturer's recommendations. Cleaning procedure shall be performed on a designated test area and shall be approved prior to proceeding with cleaning work. Discolorations which cannot be removed by these procedures, will be considered defective work. Cleaning work shall be done when temperature and humidity permit surfaces to dry rapidly. Adjacent surfaces shall not be damaged during cleaning operations.

#### 3.4 PROTECTION OF WORK

Precast units shall be protected against damage from subsequent operations.

### 3.5 DEFECTIVE WORK

Precast concrete units damaged during erection shall be repaired as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units shall match the adjacent surfaces in color and texture and shall be as approved. Unless otherwise approved, repair procedures shall conform to PCI MNL-116 and PCI MNL-117.

-- End of Section --

## SECTION 04200

MASONRY  
08/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 530.1	(1999) Specifications for Masonry Structures and Related Commentaries
ACI 318/318M	(2002) Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(1994) ACI Detailing Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(2001) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 123/A 123M	(2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2001a) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615/A 615M	(2001b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 55	(2001a) Concrete Brick
ASTM C 62	(2001) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 67	(2002) Sampling and Testing Brick and Structural Clay Tile
ASTM C 90	(2002) Loadbearing Concrete Masonry Units
ASTM C 91	(2001) Masonry Cement
ASTM C 94/C 94M	(2000e2) Ready-Mixed Concrete
ASTM C 140	(2001ae1) Sampling and Testing Concrete Masonry Units and Related Units

ASTM C 144	(1999) Aggregate for Masonry Mortar
ASTM C 150	(2002) Portland Cement
ASTM C 216	(2001a) Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 270	(2001a) Mortar for Unit Masonry
ASTM C 476	(2001) Grout for Masonry
ASTM C 494/C 494M	(1999ae1) Chemical Admixtures for Concrete
ASTM C 578	(2001) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 641	(1998e1) Staining Materials in Lightweight Concrete Aggregates
ASTM C 780	(2000) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 1019	(2000b) Sampling and Testing Grout
ASTM C 1072	(2000a) Measurement of Masonry Flexural Bond Strength
ASTM C 1142	(1995; R 2001) Extended Life Mortar for Unit Masonry
ASTM C 1289	(2001) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 1330	(1985; R 1995e1) Rubber Sheet Gaskets
ASTM D 2000	(2001) Rubber Products in Automotive Applications
ASTM D 2240	(2002) Rubber Property - Durometer Hardness
ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 119	(2000a) Fire Tests of Building Construction and Materials
ASTM E 136	(1999) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E 447	(1997) Compressive Strength of Masonry Prisms

## INTERNATIONAL CODE COUNCIL (ICC)

ICC Plumbing Code (2000) International Plumbing Code (IPA)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Masonry Work; G, AE

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings. Bar splice locations shall be shown. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1/4 inch per foot. Reinforcement bending details shall conform to the requirements of ACI SP-66.

#### SD-03 Product Data

Clay or Shale Brick  
Concrete Brick  
Insulation  
Flashing

Manufacturer's descriptive data.

##### Cold Weather Installation

Cold weather construction procedures.

#### SD-04 Samples

Concrete Masonry Units (CMU)  
Concrete Brick  
Clay or Shale Brick; G  
Mortar color; G

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit sample of colored mortar with applicable masonry unit.

##### Anchors, Ties, and Bar Positioners

Two of each type used.

#### Expansion-Joint Materials

One piece of each type used.

#### Joint Reinforcement

One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

#### Insulation

One piece of board type insulation, not less than 16 by 24 inches in size, containing the label indicating the rated permeance and R-values.

#### Portable Panel; G

One panel of clay or shale brick, 2 by 2 feet, containing approximately 24 brick facings to establish range of color and texture.

#### SD-05 Design Data

##### Pre-mixed Mortar; G

Pre-mixed mortar composition. Calculations and certifications of mortar strength.

#### SD-06 Test Reports

Field Testing of Mortar  
Field Testing of Grout  
Prism tests  
Masonry Cement  
Fire-rated CMU

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

#### Special Inspection

Copies of masonry inspector reports.

#### SD-07 Certificates

Clay or Shale Brick  
Concrete Brick  
Concrete Masonry Units (CMU)  
Control Joint Keys  
Anchors, Ties, and Bar Positioners  
Expansion-Joint Materials  
Joint Reinforcement  
Reinforcing Steel Bars and Rods  
Masonry Cement  
Mortar Coloring; G  
Insulation  
Precast Concrete Items; G  
Admixtures for Masonry Mortar; G

#### Admixtures for Grout; G

Certificates of compliance stating that the materials meet the specified requirements.

#### Insulation

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

#### SD-08 Manufacturer's Instructions

#### Masonry Cement

When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

### 1.3 SAMPLE MASONRY PANELS

After material samples are approved and prior to starting masonry work, a portable panel of clay or shale brick and sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

#### 1.3.1 Configuration

Panels shall be U-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel of an U-shaped panel shall be 8 feet long by 6 feet high.

#### 1.3.2 Composition

Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, brick stack courses and weep holes shall be shown in the sample panels. The panels shall contain a masonry bonded corner and a stacked bond corner that includes a bond beam corner.

#### 1.3.3 Construction Method

Where anchored veneer walls are required, the Contractor shall demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Temporary provisions shall be demonstrated to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on

the drawings. Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to bring up the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. If sealer is specified to be applied to the masonry units, sealer shall be applied to the sample panels. Panels shall be built on a properly designed concrete foundation.

#### 1.3.4 Usage

The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

### 1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

#### 1.4.1 Masonry Units

Concrete masonry units shall be covered or protected from inclement weather. Store Type II, concrete masonry units at the site for a minimum of 28 days for air cured units, 10 days for atmospheric steam or water cured units, and 3 days for units cured with steam at a pressure of 120 to 150 psi and at a temperature of 350 to 365 degrees F for at least 5 hours. Protect moisture controlled units (Type I) from rain and ground water. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

#### 1.4.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

#### 1.4.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

### 1.5 STRUCTURAL MASONRY

#### 1.5.1 Special Inspection

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental

body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

#### 1.5.2 Seismic Requirement

In addition to design requirements of ICC Plumbing Code, the Contractor shall provide additional seismic reinforcement in accordance with TI 809-04 SEISMIC DESIGN FOR BUILDINGS . The total minimum reinforcing percentage for structural walls shall be 0.20 percent and non-structural walls shall be 0.15 percent. The maximum spacing of reinforcing bars shall be as follows:

<u>Wall Type</u>	<u>Vertical</u>	<u>Horizontal</u>
Structural	24 inches	48 inches
Non-structural	48 inches	80 inches

Bond beams are required at the top of footings, at the bottom and top of openings at roof and floor levels, and at the top of parapet walls.

### 1.6 QUALITY ASSURANCE

#### 1.6.1 Appearance

Bricks shall be manufactured at one time and from the same batch. Blend all brick to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable.

#### 1.6.2 Testing

Masonry strength shall be determined in accordance with ACI 530.1; submit test reports on three prisms in accordance with ASTM E 447, Method B modified as specified in ACI 530.1. The cost of testing shall be paid by the Contractor.

#### 1.6.3 Spare Vibrator

Maintain at least one spare vibrator on site at all times.

#### 1.6.4 Bracing and Scaffolding

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished

work shall not be changed after the work has started except with Contracting Officer's approval.

## 2.2 CLAY OR SHALE BRICK

Color range and texture of clay or shale brick shall be as indicated and shall conform to the approved sample. Brick shall conform to ASTM C 62; Grade SW shall be used for brick in contact with earth or grade and for all exterior work. Average dimensions of brick shall be 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long (standard), subject to the tolerances specified in ASTM C 62. Brick shall be tested for efflorescence. Clay or shale brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall.

### 2.2.1 Solid Clay or Shale Brick

Solid clay or shale brick shall conform to ASTM C 216, Type FBS. Brick size shall be modular and the nominal size of the brick used shall be 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long (nominal). Minimum compressive strength of the brick shall be 1500 psi.

## 2.3 CONCRETE BRICK

Concrete brick shall conform to ASTM C 55, Type I, Grade N-I. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

## 2.4 CONCRETE MASONRY UNITS (CMU)

Cement shall have a low alkali content and be of one brand. Units shall be of modular dimensions and air, water, or steam cured. Exterior concrete masonry units shall have water-repellant admixture added during manufacture.

- a. Hollow Load-Bearing Units: ASTM C 90, Type I or II, made with lightweight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.
- b. Hollow Non-Load-Bearing Units: ASTM C 90, Type I or II, made with lightweight aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.
- c. Solid Load-Bearing Units: ASTM C 90, Type I or II, lightweight units. Provide solid units as indicated.

### 2.4.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

### 2.4.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units

used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

#### 2.4.3 Fire-Rated CMU

Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating. Construction shall conform to ASTM E 119.

TABLE I

#### FIRE-RATED CONCRETE MASONRY UNITS

See note (a) below

Aggregate Type	Minimum equivalent thickness inches for fire rating of:		
	4 hours	3 hours	2 hours
Pumice	4.7	4.0	3.0
Expanded slag	5.0	4.2	3.3
Expanded clay, shale, or slate	5.7	4.8	3.7
Limestone, scoria, cinders or unexpanded slag	5.9	5.0	4.0
Calcareous gravel	6.2	5.3	4.2
Siliceous gravel	6.7	5.7	4.5

(a) Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C 140 divided by the product of the actual length and height of the face shell of the unit in inches. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; the thickness of plaster or brick or other material in the assembly will be included in determining the equivalent thickness.

#### 2.5 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 4,000 psi minimum conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE using 1/2 inch to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 3/4 inch shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 120 psi for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or

steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

#### 2.5.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 5 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure. In reinforced masonry, lintels shall conform to ACI 318/318M for flexural and shear strength and shall have at least 8 inches bearing at each end. Concrete shall have a minimum 28 day compressive strength of 3000 psi using 1/2 inch to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A 615/A 615M Grade 60. Limit lintel deflection due to dead plus live load to  $L/600$  or 0.3 inches. Provide top and bottom bars for lintels over 36 inches in length.

#### 2.6 MORTAR FOR STRUCTURAL MASONRY

ASTM C 270, Type S. Strength ( $f'm$ ) as indicated. Test in accordance with ASTM C 780. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar.

#### 2.7 MASONRY MORTAR

Type M mortar shall conform to ASTM C 270 and shall be used for foundation walls. Mortar Type S shall conform to the proportion specification of ASTM C 270. Type N or S mortar shall be used for non-load-bearing, non-shear-wall interior masonry; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

##### 2.7.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

##### 2.7.2 Colored Mortar

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching color indicated. Quantity of pigment to cementitious content of the masonry cement shall not exceed 10 by weight; carbon black shall not exceed 3 percent by weight. Mortar coloring shall be chemically inert, of finely ground limeproof pigment, and furnished in accurately pre-measured and packaged units that can be added to a measured amount of cement. Compressive strength of colored mortar shall equal 1800 psi.

#### 2.7.3 Cement

Portland cement shall conform to ASTM C 150, Type I, II, or III. Masonry cement shall conform to ASTM C 91, Type S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.

#### 2.7.4 Pre-Mixed Mortar

Pre-mixed mortar shall conform to ASTM C 1142, Type RS.

#### 2.7.5 Sand and Water

Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

### 2.8 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 11 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

#### 2.8.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

#### 2.8.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

### 2.9 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153/A 153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

#### 2.9.1 Wall Ties

Wall ties shall be rectangular-shaped or Z-shaped fabricated of 3/16 inch

diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

#### 2.9.2 Dovetail Anchors

Dovetail anchors shall be of the flexible wire type, 3/16 inch diameter zinc-coated steel wire, triangular shaped, and attached to a 12 gauge or heavier steel dovetail section. These anchors shall be used for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Cells within vertical planes of these anchors shall be filled solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 2.9.3 Adjustable Anchors

Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

#### 2.9.4 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

#### 2.9.5 Anchors Other Than at CMU Backup Walls

Anchor assemblies for the attachment of the masonry veneer to the cold-formed steel framing, structural steel and/or concrete beam and column members, and concrete floor slabs shall be designed for the design loadings shown. Anchors shall transfer the design loadings from the masonry veneer to the cold-formed steel framing system or other support without exceeding the allowable stresses and deflections in the anchors. Length of anchor wires shall be such that the outermost wires lie between 1-1/4 inch from each face of the masonry veneer. Anchors wires shall not have drips. Wires for veneer anchors shall be rectangular or triangular hoops formed from 3/16 inch diameter steel wire conforming to ASTM A 82. Anchor assemblies including wires and anchor plates shall be hot-dip galvanized conforming to ASTM A 153/A 153M, Class B-2. The veneer anchor shall have a minimum capacity of 200 pounds. The load-displacement capacity of each veneer anchor, both in direct pull-out for tension and compression, shall be not less than 2000 pounds per inch (or a deflection of 0.05 inches per 100 pounds of load in tension or compression). In the direction perpendicular to the masonry veneer, the anchor assembly shall have a maximum play of 1/16 inch.

#### 2.9.5.1 Veneer Anchor Screws

Screws for attachment of the veneer anchors to the cold-formed steel framing members shall be as required by design to provide the needed pullout load capacity but not less than No. 12. Screws shall be shown on the detail shop drawings. The length of screws shall be such that the screws penetrate the holding member by not less than 5/8 inch.

#### 2.9.5.2 Connections

Screws, bolts and anchors shall be hot-dip galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate.

#### 2.9.5.3 Synthetic Rubber Washers

Synthetic rubber washers for placement between veneer anchors and the moisture barrier on the outside face of the exterior sheathing shall conform to ASTM D 1330, Grade I.

### 2.10 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153/A 153M, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

#### 2.11 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60 or ASTM A 616/A 616M.

#### 2.12 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000 or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inch thick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

#### 2.13 INSULATION

##### 2.13.1 Rigid Board-Type Insulation

Rigid board-type insulation shall be extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyisocyanurate shall conform to ASTM C 1289, Type I, Class 1 or 2, faced

with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

#### 2.13.1.1 Insulation Thickness and Air Space

The cavity space shall allow for a maximum insulation thickness of 1-1/2 inches, and a minimum air space of 3/4 inch.

#### 2.13.1.2 Aged R-Value

The insulation shall provide a minimum aged R-value of 7.5 for the overall thickness. The aged R-value shall be determined at 75 degrees F in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

#### 2.13.1.3 Recovered Material

Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERD MATERIALS. The polyurethane or polyisocyanurate foam shall have a minimum recovered material content of 9 percent by weight of the core material.

#### 2.13.2 Insulation Adhesive

Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

#### 2.14 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07900AJOINT SEALING.

#### 2.15 FLASHING

Flashing shall be as specified in Section 07600 SHEET METALWORK, GENERAL and Section 07416 STRUCTURAL STANDING SEAM METAL ROOF (SSMR) SYSTEM.

#### 2.16 WEEP HOLE VENTILATORS

Weephole ventilators shall be prefabricated rectangular, plastic weeps of clear butyrate with wick and brass screen to form the proper size opening in head joints, designed to allow the passage of moisture from cavities and to prevent the entrance or insects. Ventilators shall be sized to match modular construction with a standard 3/8 inch mortar joint.

#### 2.17 MEMBRANE FLASHING (ELASTOMERIC SHEET WATERPROOFING) FOR COLUMN COVERS, BEAMS, AND GYPSUM SHEATHING/CMU JUNCTURE

Elastomeric sheet waterproofing is specified in Section 07131 ELASTOMERIC

SHEET WATERPROOFING. Provide elastomeric sheet waterproofing at all columns and beams exposed to cavity of exterior wall construction and at all junctures of gypsum sheathing to CMU wall construction. Install with no voids from cavity to interior of building envelope.

## 2.18 FOAM TYPE INSULATION

Nitrogen based Amino Plast Plastic foam. Insulation shall pass ASTM E 136 exhibiting no flame or self sustained burn characteristic when heated to a temperature of 1200 degrees Fahrenheit. Foam type insulation shall fill all open CMU cores not reinforced from top of footing to first floor finish floor elevation.

## PART 3 EXECUTION

### 3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

#### 3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 90 degrees F and the wind velocity is more than 8 mph. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

#### 3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection.

##### 3.1.2.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

- a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F.
- b. Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.
- c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in

excess of 15 mph.

- d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

#### 3.1.2.2 Completed Masonry and Masonry Not Being Worked On

- a. Mean daily air temperature 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.
- b. Mean daily air temperature 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.
- c. Mean Daily Air Temperature 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.
- d. Mean Daily Temperature 20 degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

#### 3.1.3 Stains

Protect exposed surfaces of brick and precast units from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls and precast units from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

#### 3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

#### 3.1.5 Surfaces

Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

### 3.2 LAYING MASONRY UNITS

Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from

mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

### 3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

### 3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed four feet. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 48 bar diameters and wire tying them together.

### 3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

### 3.2.4 Clay or Shale Brick Units

Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Stack and soldier coursing shall be provided where indicated. Molded brick shall be laid with the frog side down. Brick that is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view.

#### 3.2.4.1 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid. Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

#### 3.2.4.2 Solid Units

Bed, head, and collar joints shall be completely filled with mortar.

#### 3.2.4.3 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

#### 3.2.4.4 Brick-Faced Walls

For brick-faced walls bond the two wythes in every sixth brick course with continuous horizontal joint reinforcement for masonry cavity wall construction. bond brick in the pattern as indicated on the drawings for cold-formed steel framing with brick veneer. Provide additional bonding ties spaced not more than 3 feet apart around the perimeter of and within 12 inches of all openings.

- a. Collar Joints: Fill collar joints solid with mortar as each course of brick is laid. Do not disturb units in place.

#### 3.2.4.5 Cavity Walls

Provide a continuous cavity as indicated. Securely tie the two wythes together with horizontal joint reinforcement. Bevel mortar beds away from cavity to prevent projection into cavity when bricks are shoved in place. Keep cavities clear and clean of mortar droppings. Provide weep holes of open head joints spaced 24 inches o.c. at base of wall and vertical obstructions (e.g. lintels). Cavity face of interior wythe shall be dampproofed in accordance with Section 07110A BITUMINOUS DAMPPROOFING.

#### 3.2.4.6 Brick Veneer

Provide a continuous cavity as indicated. Install brick veneer after sheathing, masonry anchors, and flashing have been installed to the cold-formed steel framing system. Care shall be provided to avoid damaging the moisture barrier. Damaged moisture barrier and flashing shall be

repaired or replaced before brick veneer is installed. Means shall be provided to keep cavities clean and clear of mortar droppings.

- a. Veneer Anchors at Cold-Formed Steel Framing: Veneer anchors shall be attached with screws through the sheathing to the steel studs or other support members at the locations shown. Veneer anchors shall be installed with the outermost wires lying between 5/8 inch from each face of the masonry veneer. Synthetic rubber washers shall be used between the anchor connector plates and the moisture barrier. A clutch torque slip screw gun shall be used on screws attaching veneer anchors to cold-formed steel members. Veneer anchors with corrugated sheet metal or wire mesh members extending across the wall cavity shall not be used. There shall be one veneer anchor for each two square feet of wall and shall be attached to steel studs and other supports with a maximum spacing of 24 inches on center.
- b. Flashing at Cold-Formed Steel Framing: Continuous flashing shall be provided at the bottom of the wall cavity just above grade. Flashing shall also be provided above and below openings at lintels and sills, at shelf angles, and as indicated on the drawings. Flashing shall be as detailed and as specified in Section 07600A SHEET METALWORK, GENERAL. Flashing shall be lapped a minimum of 6 inches at joints and shall be sealed with a mastic as recommended by the flashing manufacturer. Ends over doors, windows and openings shall be turned up and secured. Flashing shall be lapped under the moisture barrier a minimum of 6 inches and securely attached to the gypsum sheathing. Flashing shall extend through the exterior face of the masonry veneer and shall be turned down to form a drip.
- c. Masonry Veneer at Cold-Formed Steel Framing: Exterior masonry wythes shall be constructed to the thickness indicated on the drawings. A cavity consisting of a 1-7/8 inch minimum width air space will be provided between the moisture barrier and the masonry veneer. Masonry veneer shall not be installed until the exterior sheathing, moisture barrier, veneer anchors and flashing have been installed on the cold-formed steel framing system. Extreme care shall be taken to avoid damage to the moisture barrier and flashing during construction of the masonry veneer. Any portion of the moisture barrier and flashing that is damaged shall be repaired or replaced prior to completion of the veneer. Masonry shall be placed in running bond pattern except where stacked or soldier coursing is indicated. Vertical joints on alternating courses shall be aligned and kept vertically plumb. Solid masonry units shall be laid in a non-furrowed full bed of mortar, beveled and sloped toward the center of the wythe on which the mortar is placed. Units shall be shoved into place so that the vertical mortar joints are completely full and tight. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned and relaid. Mortar which protrudes more than 1/2 inch into the cavity space shall be removed. Means shall be provided to ensure that the cavity space is kept clean of mortar droppings and other loose debris. Chases and raked-out joints shall be kept free from mortar and debris. Faces of units used in finished exposed areas shall be free from chipped edges, material texture or color defects or other imperfections distracting from the appearance of the finished work.

## 3.2.5 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II  
TOLERANCES

Variation from the plumb in the lines  
and surfaces of columns, walls and arises

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In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations from the plumb for external corners,  
expansion joints, and other conspicuous lines

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In 20 feet	1/4 inch
In 40 feet or more	1/2 inch

Variations from the level for exposed lintels,  
sills, parapets, horizontal grooves, and other  
conspicuous lines

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In 20 feet	1/4 inch
In 40 feet or more	1/2 inch

Variation from level for bed joints and top  
surfaces of bearing walls

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In 10 feet	1/4 inch
In 40 feet or more	1/2 inch

Variations from horizontal lines

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In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch

Variations in cross sectional dimensions of  
columns and in thickness of walls

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Minus	1/4 inch
Plus	1/2 inch

## 3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

### 3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

#### 3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight.

#### 3.2.7.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

#### 3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

### 3.2.8 Joint Widths

Joint widths shall be as follows:

#### 3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

#### 3.2.8.2 Brick

Brick joint widths shall be the difference between the actual and nominal dimensions of the brick in either height or length. Brick expansion joint widths shall be as shown.

#### 3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

#### 3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Tothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

#### 3.2.11 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

#### 3.2.12 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 4 inches above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 4 inch nominal thick units shall be tied to intersecting partitions of 4 inch units, 5 inches into partitions of 6 inch units, and 7 inches into partitions of 8 inch or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 4 inches thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

### 3.3 ANCHORED VENEER CONSTRUCTION

The inner and outer wythes shall be completely separated by a continuous airspace as shown on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties.

A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

#### 3.4 WEEP HOLES

Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior. Weep holes shall be open head joints, except plastic weep

holes shall be provided at precast units and at any soldier coursing, at 24 inches o.c. Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Other approved methods may be used for providing weep holes upon approval of the Contracting Officer. Weep holes shall be kept free of mortar and other obstructions.

### 3.5 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2 hours after mixing shall be discarded.

### 3.6 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

#### 3.6.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than four feet. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

#### 3.6.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

#### 3.6.3 Electrical Conduits

Electrical conduits shall not be placed in masonry cells which contain vertical reinforcing bars.

### 3.7 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be

placed to provide not less than 5/8 inch cover to either face of the unit.

### 3.8 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

#### 3.8.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

#### 3.8.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

#### 3.8.3 Grout Holes and Cleanouts

##### 3.8.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 16 inches on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

##### 3.8.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

##### 3.8.3.3 Cleanouts for Solid Unit Masonry Construction

Cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes shall be provided at the bottom of every pour by omitting every other masonry unit from one wythe. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanout holes shall not be plugged until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

#### 3.8.4 Grouting Equipment

##### 3.8.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

##### 3.8.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

#### 3.8.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

##### 3.8.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

##### 3.8.5.2 High-Lift Method

Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 1/4 inch into the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of grout shall be limited to 4 feet in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 12 to 18 inches into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

TABLE III

## POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (feet) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (in.) (1,2)	
			Multiwythe Masonry (3)	Hollow-unit Masonry
1	Fine	Low Lift	3/4	1-1/2 x 2
5	Fine	Low Lift	2	2 x 3
8	Fine	High Lift	2	2 x 3
12	Fine	High Lift	2-1/2	2-1/2 x 3
24	Fine	High Lift	3	3 x 3
1	Coarse	Low Lift	1-1/2	1-1/2 x 3
5	Coarse	Low Lift	2	2-1/2 x 3
8	Coarse	High Lift	2	3 x 3
12	Coarse	High Lift	2-1/2	3 x 3
24	Coarse	High Lift	3	3 x 4

## Notes:

- (1) The actual grout space or cell dimension must be larger than the sum of the following items:
- The required minimum dimensions of total clear areas given in the table above;
  - The width of any mortar projections within the space;
  - The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

- (2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 3/4 inch or greater in width.
- (3) For grouting spaces between masonry wythes.
- (4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

### 3.9 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

### 3.10 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed in accordance with the details shown on the drawings. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams except the bond beam at roof line. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 3/4 inch; backer rod and sealant shall be installed in accordance with Section 07900A JOINT SEALING. Exposed interior control joints shall be raked to a depth of 1/4 inch. Concealed control joints shall be flush cut.

### 3.11 BRICK EXPANSION JOINTS AND CONCRETE MASONRY VENEER JOINTS

Brick expansion joints and concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

### 3.12 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

### 3.13 LINTELS

#### 3.13.1 Masonry Lintels

Masonry lintels shall be constructed with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar

diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

### 3.13.2 Precast Concrete and Steel Lintels

Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

### 3.14 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

### 3.15 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

#### 3.15.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

#### 3.15.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

### 3.16 INSULATION

Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

#### 3.16.1 Installation of Foam Type Insulation

Walls indicated shall be pumped with foam insulation after walls have been sealed, closed, or completed to first floor finish floor elevation. Holes drilled for foam shall be made at bed joints and repairs of holes shall be imperceptible after completion of installation or installation may be direct fill of cores exposed prior to contamination of wall above the first floor finish floor elevation. Follow manufacturers instructions for installation procedures.

### 3.17 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to

match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

### 3.17.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

### 3.17.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 1/2 cup trisodium phosphate and 1/2 cup laundry detergent to one gallon of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

### 3.18 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.19 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

### 3.20 TEST REPORTS

#### 3.20.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and

allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

### 3.20.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

### 3.20.3 Prism Tests

At least one prism test sample shall be made for each 5,000 square feet of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ASTM E 447. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than 1500 psi at 28 days. If the compressive strength of any prism falls below the specified value by more than 500 psi, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 500 psi below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

-- End of Section --

## SECTION 05120

## STRUCTURAL STEEL

07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC FCD	(1995a) Quality Certification Program Description
AISC Design Guide No. 10	(1989) Erection Bracing of Low-Rise Structural Steel Frames
AISC M013	(1983) Detailing for Steel Construction
AISC M016	(1989) ASD Manual of Steel Construction
AISC M017	(1992; Errata 1994) Connections
AISC S303	(1992) Steel Buildings and Bridges
AISC S329	(1985) Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts
AISC S335	(1989) Structural Steel Buildings Allowable Stress Design and Plastic Design
AISC S340	(1992) Metric Properties of Structural Shapes with Dimensions According to ASTM A6M

## ASME INTERNATIONAL (ASME)

ANSI/ASME B46.1	(1995) Surface Texture, (Surface Roughness, Waviness, and Lay)
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1998a) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36/A36M	(1997; Rev. A) Carbon Structural Steel
ASTM A53	(1999; Rev. B) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A123/A123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A143 (1974; R 1994) Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

ASTM A153/A153M (1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A307 (1997) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

ASTM A325M (1997) High-Strength Bolts for Structural Steel Joints (Metric)

ASTM A325 (1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A449 (2000) Standard Specification for Quenched and Tempered Steel Bolts and Studs

ASTM A490 (1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

ASTM A500 (1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A563 (1997) Carbon and Alloy Steel Nuts

ASTM A780 (1993; Rev. A) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM A992/A992M (1998e1) Steel for Structural Shapes for Use in Building Framing

ASTM C827 (1995; R 1997) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

ASTM C1107 (1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM F436 (1993) Hardened Steel Washers

ASTM F844 (1998) Washers, Steel, Plain (Flat), Unhardened for General Use

ASTM F959 (1999; Rev. A) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC PA 1	(1991) Shop, Field, and Maintenance Painting
SSPC PS 13.01	(1991) Epoxy-Polyamide Painting System

## 1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer or galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC M016 and AISC M017 except as modified in this contract.

## 1.3 MODIFICATIONS TO REFERENCES

In AISC M016, AISC M017, AISC S335, AISC S303, AISC S329, and AISC S340, except as modified in this section, shall be considered a part of AISC M016 and AISC M017 and is referred to in this section as AISC M016 and AISC M017.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Erection drawings, including description of temporary supports; G, AE

Fabrication drawings, including description of connections; G, AE

### SD-03 Product Data

Shop primer

Load indicator washers

Include test report for Class B primer.

### SD-06 Test Reports

Class B coating

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together

with the actual test results for the supplied fasteners.

#### SD-07 Certificates

Steel

Bolts, nuts, and washers

Shop primer

Welding electrodes and rods

Nonshrink grout

Galvanizing

AISC Quality Certification

Erection Plan

Welding procedures and qualifications; G, AE

#### 1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Sbd fabrication plant.

#### 1.6 QUALITY ASSURANCE

##### 1.6.1 Drawing Requirements

Submit fabrication drawings and erection drawings for approval prior to fabrication. Prepare in accordance with AISC M013, AISC M016 and AISC M017.

Drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS standard welding symbols.

##### 1.6.2 Certifications

###### 1.6.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

###### 1.6.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

#### PART 2 PRODUCTS

## 2.1 STEEL

### 2.1.1 Structural Steel Angle, Channel and Miscellaneous Shapes

ASTM A36/A36M.

### 2.1.2 Structural Steel

Wide flange shapes, ASTM A992/A992M.

### 2.1.3 Structural Steel Tubing

ASTM A500, Grade B.

### 2.1.4 Steel Pipe

ASTM A53, Type E or S, Grade B, weight class STD (Standard).

## 2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

### 2.2.1 Structural Steel

#### 2.2.1.1 Bolts

ASTM A325, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

#### 2.2.1.2 Nuts

ASTM A563, Grade and Style for applicable ASTM bolt standard recommended.

#### 2.2.1.3 Washers

ASTM F436 washers for ASTM A325 and ASTM A490 bolts.

### 2.2.2 High-Strength Structural Steel and Structural Steel Tubing

#### 2.2.2.1 Bolts

ASTM A325, Type 1 ASTM A490, Type 1 or 2.

#### 2.2.2.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

#### 2.2.2.3 Washers

ASTM F436, plain carbon steel.

### 2.2.3 Foundation Anchorage

#### 2.2.3.1 Bolts

ASTM A307 or ASTM A449 as indicated.

#### 2.2.3.2 Nuts

ASTM A563, Grade A, hex style.

#### 2.2.3.3 Washers

ASTM F844 washers for ASTM A307 bolts, and ASTM F436 washers for ASTM A449 bolts.

#### 2.2.4 Load Indicator Washers

ASTM F959.

### 2.3 STRUCTURAL STEEL ACCESSORIES

#### 2.3.1 Welding Electrodes and Rods

AWS D1.1.

#### 2.3.2 Nonshrink Grout

ASTM C1107, with no ASTM C827 shrinkage. Grout shall be nonmetallic.

#### 2.3.3 Welded Shear Stud Connectors

AWS D1.1.

### 2.4 SHOP PRIMER

SSPC Paint 25, (alkyd primer), except provide SSPC PS 13.01 epoxy-polyamide, green primer (Form 150) type 1, for all structural steel in exterior walls not galvanized. Provide a Class B coating in accordance with AISC M016 and AISC M017 for slip critical joints. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

### 2.5 GALVANIZING

ASTM A123/A123M or ASTM A153/A153M, as applicable, unless specified otherwise galvanize after fabrication where practicable. All exterior steel shelf angles and plates shall be galvanized

### 2.6 FABRICATION

#### 2.6.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

#### 2.6.2 Shop Primer

Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, surfaces designed as

part of a composite steel concrete section, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). Slip critical surfaces shall be primed with a Class B coating. Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer.

#### 2.6.2.1 Cleaning

SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

#### 2.6.2.2 Primer

Apply primer to a minimum dry film thickness of 2.0 mil except provide the Class B coating for slip critical joints in accordance with the coating manufacturer's recommendations. Repair damaged primed surfaces with an additional coat of primer.

#### 2.6.3 Fireproofing Coated Surfaces

Surfaces to receive sprayed-on fireproofing coatings shall be cleaned and prepared in accordance with the manufacturer's recommendations, and as specified in Section 07810N, "Spray-Applied Fireproofing".

### PART 3 EXECUTION

#### 3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC M016. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category SBD structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inches as determined by ANSI/ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with endorsement "P" of AISC FCD and primed with the specified paint.

#### 3.2 ERECTION

- a: Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC M016 endorsement F of AISC FCD. Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.
- b. For low-rise structural steel buildings ( 60 feet tall or less and a maximum of 2 stories), the erection plan shall conform to AISC S303 and the structure shall be erected in accordance with AISC Design Guide No. 10.

Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

### 3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

### 3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC S335. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt holes. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

#### 3.3.1 Common Grade Bolts

ASTM A307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

#### 3.3.2 High-Strength Bolts

ASTM A325 and ASTM A490 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Provide load indicator washers in all ASTM A325M or ASTM A490 bolted connections, except provide only load indicator washers for slip critical connections. Direct tension indicator tightening, shall be the only acceptable tightening methods. Use only direct tension indicator tightening for slip critical connections. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

##### 3.3.2.1 Installation of Load Indicator Washers (LIW)

ASTM F959. Where possible, the LIW shall be installed under the bolt head and the nut shall be tightened. If the LIW is installed adjacent to the turned element, provide a flat ASTM F436 washer between the LIW and nut when the nut is turned for tightening, and between the LIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat ASTM F436 washers under both the bolt head and nut when ASTM A490 bolts are used.

### 3.4 WELDING

AWS D1.1. Grind exposed welds smooth as indicated. Provide AWS D1.1 qualified welders, welding operators, and tackers.

The contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be

submitted for approval.

#### 3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas.

#### 3.5 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

##### 3.5.1 Field Priming

Field priming of steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

#### 3.6 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

#### 3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

##### 3.7.1 Welds

###### 3.7.1.1 Visual Inspection

AWS D1.1. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark all welds, including fillet weld end returns.

###### 3.7.1.2 Nondestructive Testing

AWS D1.1. Test locations shall be selected by the Contracting Officer. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer.

When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

##### 3.7.2 Load Indicator Washers

###### 3.7.2.1 Load Indicator Washer Compression

Load indicator washers shall be tested in place to verify that they have been compressed sufficiently to provide the 0.015 inch gap when the load indicator washer is placed under the bolt head and the nut is tightened, and to provide the 0.005 inch gap when the load indicator washer is placed under the turned element, as required by ASTM F959.

### 3.7.3 High-Strength Bolts

#### 3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC S329, Table 4, depending on bolt size and grade. The bolt tension shall be developed by tightening the nut. A representative of the manufacturer or supplier shall be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements.

#### 3.7.3.2 Inspection

Inspection procedures shall be in accordance with AISC S329, Section 9. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

#### 3.7.3.3 Testing

The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested. Retest new bolts after installation.

#### 3.7.4 Testing for Embrittlement

ASTM A143 for steel products hot-dip galvanized after fabrication.

-- End of Section --

## SECTION 05210A

STEEL JOISTS  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## STEEL JOIST INSTITUTE (SJI)

SJI Specs & Tables	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Steel Joists; G, AE

Detail drawings shall include fabrication and erection details, specifications for shop painting, and identification markings of joists.

## SD-07 Certificates

Steel Joists

Certificates stating that the steel joists, including special non-standard steel joists have been designed and manufactured in accordance with SJI Specs & Tables. Complete engineering design computations may be submitted in lieu of the certification.

## 1.3 GENERAL REQUIREMENTS

Steel joists are designated on the drawings in accordance with the standard designations of the Steel Joist Institute. Special non-standard steel joists are indicated on the drawings with loading requirements. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements including special joist seats are met.

#### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

### PART 2 PRODUCTS

#### 2.1 OPEN WEB STEEL JOISTS

Open web steel joists shall conform to SJI Specs & Tables, K-Series. Joists shall be designed to support the loads given in the standard load tables of SJI Specs & Tables.

#### 2.2 ACCESSORIES AND FITTINGS

Accessories and fittings, including end supports and bridging, shall be in accordance with the standard specifications under which the members were designed.

#### 2.3 SHOP PAINTING

Joists and accessories shall be shop painted with a rust-inhibiting primer paint, except joists to receive sprayed-on fireproofing. Surfaces to receive sprayed-on fireproofing coatings shall be cleaned and prepared in accordance with the manufacturer's recommendations, and as specified in Section 07810N, "Spray-Applied Fireproofing".

### PART 3 EXECUTION

#### 3.1 ERECTION

Installation of joists shall be in accordance with the standard specification under which the member was produced. Joists shall be handled in a manner to avoid damage. Damaged joists shall be removed from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Joists shall be accurately set, and end anchorage shall be in accordance with the standard specification under which the joists were produced. For spans over 40 ft through 60 ft one row of bridging nearest midspan shall be bolted diagonal bridging; for spans over 60 ft bolted diagonal bridging shall be used instead of welded horizontal bridging. Joist bridging and anchoring shall be secured in place prior to the application of any construction loads. Any temporary loads shall be distributed so that the carrying capacity of any joist is not exceeded. Loads shall not be applied to bridging during construction or in the completed work. Abraded, corroded, and field welded areas shall be cleaned and touched up with the same type of paint used in the shop painting.

#### 3.2 BEARING PLATES

Bearing plates shall be provided with full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

-- End of Section --



## SECTION 05300A

STEEL DECKING  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec S335 (1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl (1996) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 108 (1999) Steel Bars, Carbon, Cold-Finished, Standard Quality

ASTM A 611 (1997) Structural Steel (SS), Sheet, Carbon, Cold-Rolled

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 780 (2000) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

ASTM A 792/A 792M (1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

AWS D1.3 (1998) Structural Welding Code - Sheet Steel

## STEEL DECK INSTITUTE (SDI)

SDI Diaphragm Mnl (1991) Diaphragm Design Manual

SDI Pub No. 29 (1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

## THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20

(1991) Zinc-Rich Primers (Type I -  
"Inorganic" and Type II - "Organic")

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Deck Units; G, AE  
Accessories; G, AE  
Attachments; G, AE  
Holes and Openings; G, AE

Drawings shall include type, configuration, structural properties, location, and necessary details of deck units, accessories, and supporting members; size and location of holes to be cut and reinforcement to be provided; location and sequence of welded connections; and the manufacturer's erection instructions.

### SD-03 Product Data

#### Deck Units

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

#### Attachments

Prior to welding operations, copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

### SD-07 Certificates

Deck Units  
Attachments

Manufacturer's certificates attesting that the decking material meets the specified requirements. Manufacturer's certificate attesting that the operators are authorized to use the low-velocity piston tool.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deck units shall be delivered to the site in a dry and undamaged condition, stored off the ground with one end elevated, and stored under a weathertight covering permitting good air circulation. Finish of deck units shall be maintained at all times by using touch-up paint whenever necessary to prevent the formation of rust.

## PART 2 PRODUCTS

## 2.1 DECK UNITS

Deck units shall conform to SDI Pub No. 29. Panels of maximum possible lengths shall be used to minimize end laps. Deck units shall be fabricated in lengths to span 3 or more supports with flush, telescoped, or nested 2 inchlaps at ends, and interlocking, or nested side laps, unless otherwise indicated. Deck with cross-sectional configuration differing from the units indicated may be used, provided that the properties of the proposed units, determined in accordance with AISI Cold-Formed Mnl, are equal to or greater than the properties of the units indicated and that the material will fit the space provided without requiring revisions to adjacent materials or systems.

### 2.1.1 Roof Deck

Steel deck used in conjunction with insulation and built-up roofing shall conform to ASTM A 792/A 792M, ASTM A 611 or ASTM A 792/A 792M. Roof deck units shall be fabricated of 0.0358 inch design thickness or thicker steel and shall be galvanized.

### 2.1.2 Composite Deck

Deck to receive concrete as a filler or for composite deck assembly shall conform to ASTM A 653/A 653M or ASTM A 611. Deck used as the tension reinforcing in composite deck shall be fabricated of 0.0358 inch design thickness or thicker steel, and shall be zinc-coated in conformance with ASTM A 653/A 653M, G60 coating class. Deck units used in composite deck shall have adequate embossment to develop mechanical shear bond to provide composite action between the deck and the concrete. Composite deck has been designed as unshored construction.

### 2.1.3 Shear Connectors

Shear connectors shall be headed stud type, ASTM A 108, Grade 1015 or 1020, cold finished carbon steel with dimensions complying with AISC ASD Spec S335.

## 2.2 TOUCH-UP PAINT

Touch-up paint for zinc-coated units shall be an approved galvanizing repair paint with a high-zinc dust content. Welds shall be touched-up with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

## 2.3 ADJUSTING PLATES

Adjusting plates or segments of deck units shall be provided in locations too narrow to accommodate full-size units. As far as practical, the plates shall be the same thickness and configuration as the deck units.

## 2.4 CLOSURE PLATES

### 2.4.1 Closure Plates for Roof Deck

Voids above interior walls shall be closed with sheet metal where shown. Open deck cells at parapets, end walls, eaves, and openings through roofs shall be closed with sheet metal. Sheet metal shall be same thickness as deck units.

#### 2.4.2 Closure Plates for Composite Deck

The concrete shall be supported and retained at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Metal closures shall be provided for all openings in composite steel deck 1/4 inch and over, including but not limited to:

##### 2.4.2.1 Cover Plates to Close Panels

Cover plates to close panel edge and end conditions and where panels change direction or abut. Butt joints in composite steel deck may receive a tape joint cover.

##### 2.4.2.2 Column Closures to Close Openings

Column closures to close openings between steel deck and structural steel columns.

##### 2.4.2.3 Sheet Metal

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

#### 2.5 ACCESSORIES

The manufacturer's standard accessories shall be furnished as necessary to complete the deck installation. Metal accessories shall be of the same material as the deck and have minimum design thickness as follows: saddles, 0.0474 inch; welding washers, 0.0598 inch; cant strip, 0.0295 inch; other metal accessories, 0.0358 inch; unless otherwise indicated. Accessories shall include but not be limited to saddles, welding washers, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

### PART 3 EXECUTION

#### 3.1 ERECTION

Erection of deck and accessories shall be in accordance with SDI Pub No. 29 and the approved detail drawings. Damaged deck and accessories including material which is permanently stained or contaminated, with burned holes or deformed shall not be installed. The deck units shall be placed on secure supports, properly adjusted, and aligned at right angles to supports before being permanently secured in place. The deck shall not be filled with concrete, used for storage or as a working platform until the units have been secured in position. Loads shall be distributed by appropriate means to prevent damage during construction and to the completed assembly. The maximum uniform distributed storage load shall not exceed the design live load. There shall be no loads suspended directly from the steel deck.

#### 3.2 ATTACHMENTS

All fasteners shall be installed in accordance with the manufacturer's recommended procedure, except as otherwise specified. The deck units shall be welded with nominal 5/8 inch diameter puddle welds to supports as indicated on the design drawings and in accordance with requirements of SDI Pub No. 29. All welding of steel deck shall be in accordance with AWS D1.3

using methods and electrodes as recommended by the manufacturer of the steel deck being used. Welds shall be made only by operators previously qualified by tests prescribed in AWS D1.3 to perform the type of work required. Welding washers shall not be used at the connections of the deck to supports. Welding washers shall not be used at sidelaps. Holes and similar defects will not be acceptable. Metal deck damaged as a result of welding shall be replaced or repaired in accordance with the deck manufacturer's written instructions as approved by the Contracting Officer.

Deck ends shall be lapped 2 inches. All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of SDI Diaphragm Mnl. Shear connectors shall be attached as shown and shall be welded as per AWS D1.1 through the steel deck to the steel member.

### 3.3 HOLES AND OPENINGS

All holes and openings required shall be coordinated with the drawings, specifications, and other trades. Holes and openings shall be drilled or cut, reinforced and framed as indicated on the drawings or described in the specifications and as required for rigidity and load capacity. Holes and openings less than 6 inches across require no reinforcement. Holes and openings 6 to 12 inches across shall be reinforced by 0.0474 inch thick steel sheet at least 12 inches wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inches on center. Holes and openings larger than 12 inches in any direction shall be reinforced by steel angles (3"x3"x1/4" minimum) installed perpendicular to the steel joists and supported by the adjacent steel joists. Steel angles shall be installed perpendicular to the deck ribs and shall be fastened to the angles perpendicular to the steel joists. Openings must not interfere with seismic members such as chords and drag struts.

### 3.4 PREPARATION OF FIRE-PROOFED SURFACES

Deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, shall be galvanized and shall be free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Any required cleaning shall be done prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

-- End of Section --

## SECTION 05400A

COLD-FORMED STEEL FRAMING  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Spec (1996) Specification & Commentary for the Design of Cold-Formed Steel Structural Members (Part V of the Cold-Formed Steel Design Manual)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 370 (1997a) Mechanical Testing of Steel Products

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B 633 (1985; R 1998) Electrodeposited Coatings of Zinc on Iron and Steel

ASTM C 955 (2000a) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

ASTM E 329 (2000b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.3 (1998) Structural Welding Code - Sheet Steel

## SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 78 (1998) Steel Self Drilling Tapping Screws

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Framing Components; G, AE

- a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.
- b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.
- c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

#### SD-07 Certificates

##### Mill Certificates

Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E 329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A 370.

##### Welds

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3.

### 1.3 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered and handled preventing bending or other damage, and avoiding contact with soil or other contaminating materials. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust.

## PART 2 PRODUCTS

### 2.1 STEEL STUDS, TRACKS, BRACING, BRIDGING, AND ACCESSORIES

Framing components shall comply with ASTM C 955 and the following:

- a. Material shall be corrosion-resistant steel complying with ASTM A 653/A 653M, Grade 50, having a minimum yield of 50,000 psi and a G 60 minimum zinc coating. Framing covered herein shall be used only in framing the exterior steel stud wall system and the steel stud roof over-framing. For interior steel stud partitions refer to Section 09250, "Gypsum Board." For masonry brick veneer refer to Section 04200, "Masonry."

- b. Minimum uncoated steel thickness (design thickness times 0.95):
  - (1). Studs and Tracks: 0.0538 inch.
  - (2). Bracing and bridging: Thickness as recommended by the stud manufacturer.
  - (3). Accessories: Standard thickness as provided by the manufacturer.
- c. Stud and Track web depth:
  - (1). Exterior Wall Studs: 8 inches.
  - (2). Roof Over-Framing Studs: 3-5/8 inches.
- d. Stud flange width: 2 inches.
  - (1). Exterior Wall Studs: 2 inches.
  - (2). Roof Over-Framing Studs: 1-5/8 inches.
- e. Stud effective section properties for exterior wall studs:
  - (1).  $S_x = 1.71 \text{ in}^3$
  - (2).  $I_x = 6.84 \text{ in}^4$
  - (3).  $M_x = 43,000 \text{ in-lb}$
- f. Stud effective section properties for roof over-framing studs:
  - (1).  $S_x = 0.49 \text{ in}^3$
  - (2).  $I_x = 0.89 \text{ in}^4$
  - (3).  $M_x = 10,700 \text{ in-lb}$

## 2.2 MARKINGS

Studs and track shall have product markings on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

- a. Manufacturer's identification.
- b. Minimum delivered uncoated steel thickness.
- c. Protective coating designator.
- d. Minimum yield strength.

## 2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling tapping in compliance with SAE J 78 of the type, size, and location as shown on the

drawings. Electroplated screws shall have a Type II coating in accordance with ASTM B 633. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate. Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A 123/A 123Mor ASTM A 153/A 153M as appropriate.

### PART 3 EXECUTION

#### 3.1 Delivery, Handling and Storage

a. Materials shall be delivered and handled in a manner to avoid bending or other damage and to avoid contact with the soil or other contaminating materials.

b. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content galvanizing repair paint whenever necessary to prevent the formation of rust.

#### 3.2 CONNECTIONS

##### 3.2.1 Welds

All welding shall be performed in accordance with AWS D1.3, as modified by AISI Cold-Formed Spec. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3. All welds shall be cleaned and coated with rust inhibitive galvanizing paint.

##### 3.2.2 Screws

Screws shall be self-drilling self-tapping type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI Cold-Formed Spec. Screws covered by sheathing materials shall have low profile heads.

##### 3.2.3 Anchors

Anchors shall be of the type, size, and location shown on the drawings.

#### 3.3 INSTALLATION

##### 3.3.1 General Requirements

- a. Prefabricated frames shall be square, with components attached to prevent racking during fabrication, transportation, and lifting. Design and construction of frames shall include provisions for lifting.
- b. Cutting of steel framing shall be by saw, shear, or plasma cutting equipment. Oxyacetylene torch cutting is not permitted.
- c. Temporary bracing shall be provided and remain in place until work is permanently stabilized.
- d. Abutting lengths of track shall be butt-welded, spliced, or each length securely anchored to a common structural element. Track shall be securely anchored to the supporting structure as shown on the drawings.

- e. Splicing of framing components, other than track and tension members, is not permitted.
- f. Wire tying of framing members is not permitted.

### 3.3.2 Exterior Stud Walls (Curtain walls)

- a. Studs shall be spaced at 16 inches on center.
- b. Studs shall be plumbed, aligned, and secured to the continuous runner tracks at each end, unless the stud end terminates at a deflection track.
- c. Tracks shall be securely anchored to the supporting structure as shown on the drawings.
- d. Mechanical Bracing/Bridging spaced at 60 inches (max.) shall be installed prior to the installation of facing materials. The bracing shall develop the resisting moment capacity indicated in paragraph 2.1(e) without relying on facing materials for bracing.
- e. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall.
- f. At wall openings for doors, windows and other similar features, the framing system shall provide for the installation and anchorage of the required subframes or finish frames. Steel frames shall be securely attached through built-in anchors to the nearest stud on each side of the opening with self-drilling screws. Double studs shall be provided at both jambs of all door openings.
- g. Installation of sheathing, wallboards, or any other collateral material shall be performed in accordance with the product manufacturer's specifications.
- h. Components (Deflection Track and/or Slide Clips) shall be provided at connections to structural members and at underside of floors or roof deck to accommodate potential movements of Primary Frames. Construction shall accommodate a vertical movement of 3/4 inches.

### 3.3.3 Roof Over-Framing Studs

- a. Studs shall be spaced at 16 inches on center.
- b. Studs shall be bridged and braced before the installation of collateral materials. The bracing shall develop the resisting moment capacity indicated in paragraph 2.1(f) without relying on facing materials for bracing.
- d. Temporary bracing shall be provided and remain in place until work is permanently stabilized.

### 3.4 TOLERANCES

Vertical alignment (plumbness) of studs shall be within 1/960th of the span. Horizontal alignment (levelness) of walls shall be within 1/960th of their respective lengths. Spacing of studs shall not be more than plus

1/8 inch from the designed spacing providing the the cumulative error does not exceed the requirements of the finishing material.

-- End of Section --

## SECTION 05500A

MISCELLANEOUS METAL  
01/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3 (1992) Ladders - Fixed - Safety Requirements

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 36/A 36M (2000a) Carbon Structural Steel

ASTM A 500 (1999) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 53/A 53M (2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 924/A 924M (1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-344 (Rev B) Lacquer, Clear Gloss, Exterior, Interior

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Miscellaneous Metal Items; G, AE.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items: Handrails, guards, steel stairs, railings, safety nosings, projector mounts, projector screen mounts.

## 1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

## 1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

## 1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

## 1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

## 1.7 ALUMINUM FINISHES

Unless otherwise specified, aluminum items shall have brushed aluminum finish. Aluminum surfaces to be in contact with plaster or concrete during construction shall be protected with a field coat conforming to CID A-A-344.

## 1.8 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

## PART 2 PRODUCTS

### 2.1 ACCESS DOORS AND PANELS

Doors and panels shall be flush type unless otherwise indicated. Frames for access doors shall be fabricated of not lighter than 16 gauge steel with welded joints and finished with anchorage for securing into construction. Access doors shall be a minimum of 14 by 20 inches and of not lighter than 14 gauge steel, with stiffened edges, complete with attachments. Access doors shall be hinged to frame and provided with a flush face, screw driver operated latch. Exposed metal surfaces shall have a shop applied prime coat.

### 2.2 PIPE GUARDS

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53/A 53M, Type E or S, weight STD, galvanized with painted finish.

### 2.3 HANDRAILS

Handrails shall be designed to resist a concentrated load of 200 pounds in any direction at any point of the top of the rail or 20 pounds per foot applied horizontally to top of the rail, whichever is more severe.

#### 2.3.1 Steel Handrails, Railings, and Guards Including Carbon Steel Inserts

Steel handrails, railings, and guards, including inserts in concrete, shall be steel pipe conforming to ASTM A 53/A 53M or structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength. Steel railings shall be size as indicated. Railings, handrails, and guards shall be hot-dip galvanized for exterior applications and shop painted for interior applications. Pipe collars shall be hot-dip galvanized steel.

- a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

- (1) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 6 inches long.

- (2) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

b. Toe-boards and brackets shall be provided as indicated.

### 2.3.2 Attic Guardrails

Steel attic guardrails shall be of sizes and shapes as indicated conforming to ASTM A 36/A 36M. Railings shall be shop painted. Components shall be welded into singular units. Where multiple sections are required for erection, splices shall be made by splicing in field and welding.

### 2.4 LADDERS

Ladders shall be galvanized steel, fixed rail type in accordance with ANSI A14.3.

### 2.5 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

### 2.6 SAFETY NOSING

Safety nosings at loading dock stairs shall be of cast aluminum with cross-hatched, abrasive surface. Nosing shall be 3 inches wide and terminating at not more than 6 inches from the ends of treads. Safety nosings shall be provided with anchors not less than 3/4 inch long. Integrally cast mushroom anchors are not acceptable.

### 2.7 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel or tube steel stringers as indicated, metal pan cement-filled treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36/A 36M. Stairs and accessories shall be shop primed. Risers on stairs with metal pan treads shall be deformed to form a sanitary cove to retain the tread concrete. Integral nosings shall have braces extended into the concrete fill.

### 2.8 STEEL DOOR FRAMES

Steel door frames at rolling door shall be built from structural shapes securely welded. Provision shall be made to stiffen the top member for all spans over 3 feet.

### 2.9 SADDLE

Provide aluminum saddles full width of opening and width as indicated on the drawings. Profiles of saddles shall be as indicated and shall be maximum 1/4 inch in height. Provide beveled leading edges to all saddles.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

### 3.2 INSTALLATION OF PIPE GUARDS

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE having a compressive strength of 3000 psi.

### 3.3 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints.

#### 3.3.1 Installation of Steel Handrails

Installation shall be in pipe sleeves embedded in concrete and filled with molten lead or sulphur with anchorage covered with standard pipe collar pinned to post by means of pipe sleeves secured to steel reinforcing in metal stud walls with screws, welded to masonry with expansion shields and bolts or toggle bolts, welded to stringers, guards, or structural steel framework. Rail ends shall be secured by similar anchorage devices.

### 3.4 INSTALLATION OF SAFETY NOSINGS

Nosing at exterior stairs shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

### 3.5 DOOR FRAMES

Door frames shall be secured to the floor slab by means of angle clips and expansion bolts. Any necessary reinforcements shall be made and the frames shall be drilled and tapped as required for hardware.

-- End of Section --

## SECTION 06100A

## ROUGH CARPENTRY

**02/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN FOREST &amp; PAPER ASSOCIATION (AF&amp;PA)

- AF&PA T101 (1991; Supple 1993; Addenda Apr 1997; Supple T02) National Design Specification for Wood Construction
- AF&PA T11 (1988) Manual for Wood Frame Construction \*\*

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 307 (2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- ASTM C 79/C 79M (1997) Treated Core and Nontreated Core Gypsum Sheathing Board
- ASTM C 1177/C 1177M (1999) Glass Mat Gypsum Substrate for Use as Sheathing
- ASTM C 518 (1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- ASTM C 612 (2000) Mineral Fiber Block and Board Thermal Insulation
- ASTM C 665 (1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
- ASTM C 79/C 79M (2000) Treated Core and Nontreated Core Gypsum Sheathing Board
- ASTM C 954 (2000) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
- ASTM D 226 (1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
- ASTM D 412 (1998) Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and

## Thermoplastic Elastomers-Tension

ASTM D 624	(2000) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 2898	(1994; R 1999) Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM E 154	(1988; R 1999) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000) Water Vapor Transmission of Materials
ASTM F 547	(1977; R 1995) Definitions of Terms Relating to Nails for Use with Wood and Wood-Based Materials

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(2000) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C20	(1999) Structural Lumber Fire-Retardant Pressure Treatment
AWPA C27	(1999) Plywood - Fire-Retardant Pressure Treatment
AWPA C9	(1997) Plywood - Preservative Treatment by Pressure Processes
AWPA M4	(1999) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(2000) Standards for Waterborne Preservatives

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM LPD 1-49	(1995) Loss Prevention Data Sheet - Perimeter Flashing
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## NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules	(1994) Rules for the Measurement & Inspection of Hardwood & Cypress
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## NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules	(1997) Standard Grading Rules for Northeastern Lumber
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## REDWOOD INSPECTION SERVICE (RIS)

RIS GCRL	(1997) Grades of California Redwood Lumber
SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)	
SCMA Spec	(1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress
SOUTHERN PINE INSPECTION BUREAU (SPIB)	
SPIB Rules	(1994; Supple 8 thru 11) Standard Grading Rules for Southern Pine Lumber

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-07 Certificates

#### Grading and Marking

Manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

#### Insulation

Certificate attesting that the insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity.

## PART 2 PRODUCTS

### 2.1 LUMBER AND SHEATHING

#### 2.1.1 Grading and Marking

##### 2.1.1.1 Lumber Products

Solid sawn lumber shall bear an authorized gradestamp or grademark recognized by ALSC, or an ALSC recognized certification stamp, mark, or hammerbrand. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

#### 2.1.1.2 Plywood Products

Materials shall bear the grademark or other identifying marks indicating grades of material and rules or standards under which produced, including requirements for qualifications and authority of the inspection organization. Except for plywood and wood structural panels, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

#### 2.1.2 Sizes

Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Unless otherwise specified, sizes indicated are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

#### 2.1.3 Treatment

Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil. Except as specified for all-heart material of the previously mentioned species, the following items shall be treated:

- a. Wood members in contact with or within 18 inches of soil.
- b. Wood members in contact with water.
- c. Wood members exposed to the weather and those used in roofing systems or as nailing strips or nailers over fiberboard or gypsum-board wall sheathing as a base for wood siding.
- d. Wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.
- e. Wood members in contact with concrete that is in contact with soil or water or that is exposed to weather.

##### 2.1.3.1 Lumber and Timbers

Lumber and timbers shall be treated in accordance with AWPA C2 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

- a. 0.25 pcf intended for above ground use.
- b. 0.40 pcf intended for ground contact and fresh water use.

##### 2.1.3.2 Plywood

Plywood shall be treated in accordance with AWPA C9 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

- a. 0.25 pcf intended for above ground use.
- b. 0.40 pcf intended for ground contact and fresh water use.

#### 2.1.4 Moisture Content

At the time lumber and other materials are delivered and when installed in the work their moisture content shall be as follows:

a. Treated and Untreated Lumber Except Roof Planking: 4 inches or less, nominal thickness, 19 percent maximum. 5 inches or more, nominal thickness, 23 percent maximum in a 3 inch perimeter of the timber cross-section.

b. Materials Other Than Lumber: In accordance with standard under which product is produced.

#### 2.1.5 Fire-Retardant Treatment

Fire-retardant treated wood shall be pressure treated in accordance with AWPA C20 for lumber and AWPA C27 for plywood. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type A and B and Exterior Type. Treatment and performance inspection shall be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting shall be subjected to an accelerated weathering technique in accordance with ASTM D 2898 prior to being tested for compliance with AWPA C20 or AWPA C27. Items to be treated include: All wood except for wood associated with roofing and fascia.

#### 2.1.6 Sheathing

Sheathing shall be gypsum board for wall sheathing.

##### 2.1.6.1 Gypsum Sheathing Board

Glass mat gypsum sheathing that is installed on the exterior side of the cold-formed steel framing system shall have a minimum thickness of 1/2 inch and shall be 4 feet wide with straight edges for supports 16 inches on center. Glass mat gypsum sheathing shall conform to ASTM C 79/C 79M and ASTM C 1177/C 1177M. Glass mat gypsum sheathing shall have a water-resistant core with a water-resistant glass mat embedded onto core and shall have a zero flame, zero smoke developed, and shall have mold and mildew resistant surface. Gypsum sheathing board shall be warranted for at least 6 months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing. All joints, seams and penetrations shall be sealed with compatible sealant.

##### 2.1.6.2 Glass Mat Covered Gypsum Sheathing Sealant

Sealant shall be compatible with gypsum sheathing, rubber washers for masonry veneer anchors, and other associated cavity wall components such as anchors and through wall flashing. Sealants for gypsum sheathing board edge seams and veneer anchor penetrations shall be the type recommended by the gypsum sheathing manufacturer and have the following performance requirements:

- a. ASTM D 412: Tensile Strength - 80 psi
- b. ASTM D 412: Ultimate Tensile Strength (maximum elongation) - 170

psi

- c. ASTM D 624: Tear Strength, dieB, - 27 ppi
- d. ASTM D 1149: Joint Movement Capability after 14 Days cure - percent  $\pm$  50

#### 2.1.7 Moisture Protection

##### 2.1.7.1 Moisture Barrier

The moisture barrier shall be 15-lb asphalt-saturated felt conforming to ASTM D 226 Type I (No. 15).

##### 2.1.7.2 Vapor Retarder

The vapor retarder shall be polyethylene sheeting conforming to ASTM E 154. Vapor retarder shall have a maximum vapor permeance rating of 0.5 perms as determined in accordance with ASTM E 96, unless otherwise specified.

##### 2.1.7.3 Staples

Staples for attaching the moisture barrier to the exterior sheathing shall be the type and size best suited to provide a secure connection. Staples shall be made from stainless steel wire.

##### 2.1.7.4 Joint Tape

Tape for sealing the joints in the vapor retarder shall be laminated tape with pressure sensitive adhesive as recommended by the manufacturer of the polyethylene film.

#### 2.1.8 Miscellaneous Wood Members

##### 2.1.8.1 Nonstress Graded Members

Members shall include nailing strips. Members shall be in accordance with TABLE I for the species used. Sizes shall be as follows unless otherwise shown:

Member	Size (inch)
Nailing strips	1 x 3 or 1 x 4 when used as shingle base or interior finish, otherwise 2 inch stock.

##### 2.1.8.2 Blocking

Blocking shall be standard or number 2 grade.

##### 2.1.8.3 Rough Bucks and Frames

Rough bucks and frames shall be straight standard or number 2 grade.

#### 2.2 ACCESSORIES AND NAILS

Markings shall identify both the strength grade and the manufacturer. Accessories and nails shall conform to the following:

### 2.2.1 Anchor Bolts

ASTM A 307, size as indicated, complete with nuts and washers.

### 2.2.2 Bolts: Lag, Toggle, and Miscellaneous Bolts and Screws

Type, size, and finish best suited for intended use. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.

### 2.2.3 Clip Angles

Steel, 3/16 inch thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

### 2.2.4 Expansion Shields

Type and size best suited for intended use.

### 2.2.5 Gypsum Sheathing Screws

Screws for attachment of gypsum sheathing to cold-formed steel framing shall conform to ASTM C 954.

### 2.2.6 Caulking and Sealants

Caulking and sealants shall be as specified in Section 07900A JOINT SEALING.

### 2.2.7 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be stainless steel and as recommended by the manufacturer of the materials to be joined. In general, 8-penny or larger nails shall be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails shall be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AF&PA T11. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AF&PA T101. Reasonable judgement backed by experience shall ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

## 2.3 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown.

R-values shall be determined at 75 degrees F in accordance with ASTM C 518.

Insulation shall contain the highest practicable percentage of recovered material which has been recovered or diverted from solid waste, but not including material reused in a manufacturing process. Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. Insulation shall be the standard product of a manufacturer and factory marked or identified with manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Materials containing more than one percent asbestos will not be allowed.

### 2.3.1 Batt or Blanket

#### 2.3.1.1 Glass Fiber Batts and Rolls

Glass fiber batts and rolls shall conform to ASTM C 665, Type I unfaced insulation for use in exterior walls. Type II kraft faced insulation for use in exterior soffits, having a UL rating of 25 and a smoke developed rating of 150 or less when tested in accordance with ASTM E 84. Width and length shall suit construction conditions.

#### 2.3.1.2 Mineral Fiber Batt

Mineral fiber batt shall conform to ASTM C 665, Type I unfaced insulation for acoustical and fire.

### 2.3.2 Sill Sealer

Mineral wool, 1 inch thick and compressible to 1/32 inch, width of sill, designed to perform as an air, dirt, and insect seal in conformance with ASTM C 665, Type I.

### 2.3.3 Rigid Insulation

#### 2.3.3.1 Glass Fiber Insulation Board for Direct Attachment to Back of Spandrel Glass, Interior Face of CMU Below Raised Access Floor, and Between Steel Beams/Columns and Gypsum Board Finishes

Glass mat gypsum roof board shall conform to ASTM C 1177/C 1177M, flame spread 0, smoke developed 0, psi 500, water resistant. Glass fiber insulation board shall conform to ASTM C 612, Type 1A and one inch in thickness, unless otherwise indicated.

## PART 3 EXECUTION

### 3.1 GYPSUM WALLBOARD

Gypsum wallboard shall be installed on the interior face of the cold-formed steel framing system. Installation shall be as specified in Section 09250 GYPSUM BOARD except at vertical slip joints, the gypsum wallboard shall be connected to the vertical studs to prevent movement at the slip joint.

### 3.2 EXTERIOR SHEATHING

Sheathing shall be installed on the exterior face of the cold-formed steel framing system with self-drilling screws. Screws shall be located a minimum of 3/8 inch from the ends and edges of sheathing panels and shall be spaced not more than 8 inches on each supporting member except at vertical slip joints, the sheathing shall be connected to the vertical studs to prevent movement of the slip joint. Edges and ends of gypsum sheathing panels shall be butted snugly with vertical joints staggered to provide full and even support for the moisture barrier. Joints shall be filled with exterior rubber base caulk. Holes and gaps resulting from abandoned screw installations, from damage to panels, and from cutting and fitting of panels at junctures with doors, windows, foundation walls, floor slabs and other similar locations shall be filled with exterior rubber-base caulk.

### 3.3 MOISTURE PROTECTION

### 3.3.1 Moisture Barrier

The asphalt-saturated felt or other approved moisture barrier shall be installed on the outer face of the exterior sheathing. The moisture barrier shall be installed horizontally and shingled with each sheet lapped not less than 6 inches over the sheet below. Vertical end joints shall be lapped not less than 6 inches and shall be staggered. Attachment of the moisture barrier shall be with staples spaced not greater than 16 inches on center or as required by the manufacturer.

### 3.3.2 Vapor Retarder

A vapor retarder shall be installed between the steel studs and the interior gypsum board finish. The vapor retarder shall be installed in accordance with the manufacturer's recommendations to form a complete retarder to vapor infiltration. The joints shall be lapped and sealed with tape. Vapor retarder shall be applied to provide a continuous barrier at window and door frames, and at all penetrations such as electrical outlets and switches, plumbing connections, and utility service penetrations.

## 3.4 INSTALLATION OF MISCELLANEOUS WOOD MEMBERS

### 3.4.1 Blocking

Blocking shall be provided as necessary for application of building items. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

### 3.4.2 Nailers and Nailing Strips

Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Stacked nailers shall be assembled with spikes or nails spaced not more than 18 inches on center and staggered. Beginning and ending nails shall not be more than 6 inches for nailer end. Ends of stacked nailers shall be offset approximately 12 inches in long runs and alternated at corners. Anchors shall extend through the entire thickness of the nailer. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place. Nailers and nailer installation for Factory Mutual wind uplift rated roof systems specified in other Sections of these specifications shall conform to the recommendations contained in FM LPD 1-49.

### 3.4.3 Rough Bucks and Frames

Rough bucks shall be set straight, true, and plumb, and secured with anchors near top and bottom of each wood member and at intermediate intervals of not more than 3 feet. Anchors for concrete shall be expansion bolts, and anchors for masonry shall be 3/16 x 1-1/4 inch steel straps extending not less than 8 inches into the masonry and turned down 2 inches into the masonry.

## 3.5 INSTALLATION OF INSULATION

Insulation shall be installed after construction has advanced to a point that the installed insulation will not be damaged by remaining work. For thermal insulation the actual installed thickness shall provide the R-values shown. For acoustical insulation the installed thickness shall be

1-1/2 inches thick in 2-1/2 inch studs and 3 inches thick in 3-1/2 inch studs. Insulation shall be installed on the weather side of such items as electrical boxes and water lines. Unless otherwise specified, installation shall be in accordance with the manufacturer's recommendation.

3.6 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section 01452A SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

3.7 INSTALLATION OF AIR INFILTRATION BARRIER

Air infiltration barrier shall be installed in accordance with the manufacturer's recommendations.

3.8 TABLES

TABLE I. SPECIES AND GRADE

Blocking and Furring

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm	No. 3 Comm
NHLA Rules	Cypress			X	
NELMA Grading Rules	Northern White Cedar				X
	Eastern White Pine	X			
	Northern Pine	X			
	Balsam Fir				X
	Eastern Hemlock-Tamarack				X
RIS GCRL	Redwood		X		
SCMA Spec	Cypress			X	
SPIB Rules	Southern Pine		X		

-- End of Section --

## SECTION 06200A

## FINISH CARPENTRY

11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 547 (1977; R 1995) Definitions of Terms  
Relating to Nails for Use with Wood and  
Wood-Based Materials

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C20 (1999) Structural Lumber Fire-Retardant  
Pressure Treatment

AWPA C27 (1999) Plywood - Fire-Retardant Pressure  
Treatment

AWPA C9 (1997) Plywood - Preservative Treatment by  
Pressure Processes

AWPA M4 (1999) Standard for the Care of  
Preservative-Treated Wood Products

AWPA P5 (2000) Standards for Waterborne  
Preservatives

## NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules (1997) Standard Grading Rules for  
Northeastern Lumber

## REDWOOD INSPECTION SERVICE (RIS)

RIS GCRL (1987) Grades of California Redwood Lumber

## SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

SCMA Spec (1986; Supple No. 1, Aug 1993) Standard  
Specifications for Grades of Southern  
Cypress

## SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB Rules (1994; Supple 8 thru 11) Standard Grading  
Rules for Southern Pine Lumber

## WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17 (1996; Supples VII(A-E), VIII(A-C)) Grading  
Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA Grading Rules (1999) Western Lumber Grading Rules 95

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMPMA)

WMPMA WM 6 (1987) Industry Standard for Non-Pressure  
Treating of Wood Millwork

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Finish Carpentry

Drawings showing fabricated items and special mill and woodwork items. Drawings shall indicate materials and details of construction, methods of fastening, erection, and installation.

### SD-03 Product Data

#### Wood Items and Trim

Manufacturer's printed data indicating the usage of engineered or recycled wood products, and environmentally safe preservatives.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well-ventilated areas, and protected from extreme changes in temperature and humidity.

## PART 2 PRODUCTS

### 2.1 WOOD ITEMS AND TRIM

The Contractor shall furnish products which optimize design by reducing the amount of wood used (engineered wood), by using recycled wood products and preservatives without arsenic or chromium when the products and methods are competitive in price or directed by the Contracting Officer.

#### 2.1.1 Grading and Marking

Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on a material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of

authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Except for plywood, wood structural panels, and lumber, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.

#### 2.1.2 Sizes and Patterns

Lumber sizes and patterns shall conform to rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Sizes and patterns for materials other than lumber shall conform to requirements of the rules or standards under which produced. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

#### 2.1.3 Moisture Content

The maximum moisture content of untreated trim and wood siding shall be 15 percent at the time of delivery to the jobsite and when installed. Moisture content of all other material shall be in accordance with the standard under which the product is produced.

#### 2.1.4 Preservative Treatment

##### 2.1.4.1 Plywood

Plywood shall be treated in accordance with AWPA C9 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

- a. 0.25 pcf intended for above ground use.
- b. 0.4 pcf intended for ground contact and fresh water use.

##### 2.1.4.2 Exterior Wood Molding and Millwork

Exterior wood molding and millwork within 18 inches of soil, in contact with water or concrete shall be preservative-treated in accordance with WMMPA WM 6. Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWPA M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil.

#### 2.1.5 Fire-Retardant Treatment

Fire-retardant treated plywood for use as electrical backboards shall be pressure treated in accordance with AWPA C27. Material use shall be defined in AWPA C20 and AWPA C27 for Interior Type A. Treatment and performance inspection shall be by a qualified independent testing agency that establishes performance ratings. Each piece or bundle of treated material shall bear identification of the testing agency to indicate performance with such rating.

#### 2.1.6 Trim

##### 2.1.6.1 Wood

Trim shall be species and grade listed in TABLE I at the end of this section. Sizes shall be as indicated.

#### 2.1.7 Moldings

Moldings shall be of the pattern indicated and shall be of a grade compatible with the finish specified.

#### 2.1.8 Woodwork Items

##### 2.1.8.1 Utility Shelving

Utility shelving shall be a suitable species equal to or exceeding requirements of No. 3 Common white fir under WWPA Grading Rules, 1 inch thick; or plywood, interior type, Grade A-B, 1/2 inch thick, any species group.

#### 2.2 NAILS

Nails shall be the size and type best suited for the purpose and shall conform to ASTM F 547. Nails shall be hot-dip galvanized or aluminum when used on exterior work. Screws for use where nailing is impractical shall be size best suited for purpose.

### PART 3 EXECUTION

#### 3.1 EXTERIOR TRIM

Exposed surfaces and square edges shall be machine sanded, caulked, and constructed to exclude water. Joints of built-up items, in addition to nailing, shall be glued as necessary for weather-resistant construction. End joints in built-up members shall be well distributed. Joints in flat work shall be shouldered. Backs of wide-faced miters shall be held together with metal rings and glue. Fascias and other flat members shall be in maximum practicable lengths. Cornices shall be braced, blocked, and rigidly anchored for support and protection of vertical joints.

#### 3.2 MOLDING AND INTERIOR TRIM

Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded work shall be coped at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a nonstaining putty to match the finish applied. Screws shall be used for attachment to metal; setting and stopping of screws shall be of the same quality as required where nails are used.

#### 3.3 WOODWORK ITEMS

##### 3.3.1 Shelving

Shelving shall be anchored to supporting construction. Unless otherwise indicated, shelves shall be supported by wall-supported brackets not more than 24 inches on center or as required to limit deflection to 1/4 inch between supports with a load of 35 lb per lineal foot.

##### 3.3.2 Clothes Hanger Rods

Rods shall be provided where indicated and in all closets having hook strips. Rods shall be hardwood 1-1/2 inches in diameter. Rods shall be set parallel with the front edges of the shelving, and shall be supported at each end by suitable sockets, and by intermediate brackets spaced at not more than 4 foot centers.

### 3.4 TABLES

TABLE I. SPECIES AND GRADE TABLES

Grading Rules	Species	Choice	Clear	C Select	C & Better
NELMA Grading Rules					
	Eastern Cedar				X
	Eastern Hemlock		X		
	Tamarack				X
	Eastern W. Pine				X
	Northern Pine				X
	Eastern Spruce			X	
	Balsam Fir		X		
RIS GCRL	Redwood		X		
SCMA Spec	Cypress			X	
SPIB Rules	Southern Pine				X
WCLIB 17	Douglas Fir				X
	Larch				X
	Hemlock Fir				X
	Mountain Hemlock				X
	Sitka Spruce				X
WWPA Grading Rules					
	Douglas Fir				X
	Larch				X
	Hemlock Fir		X		
	Mountain Hemlock				X
	Western Larch		X		
	Idaho White Pine	X			
	Lodgepole Pine		X		
	Ponderosa Pine		X		
	Sugar Pine		X		
	Englemann Spruce		X		
	Douglas Fir South		X		
	Subalpine Fir		X		

NOTE 1: Western Cedar under WCLIB 17 shall be Grade B; and under WWPA Grading Rules, Western Cedar shall be Grade B bevel for siding and Grade A for trim.

NOTE 2: Except as specified in NOTE 3 below, siding and exterior trim shall be any of the species listed above. Interior trim shall be any one of the species listed above and the highest grade of the species for stain or natural finish and one grade below highest grade of species for paint finish.

NOTE 3: Southern Yellow Pine, Douglas Fir, Larch, Western Larch, and Tamarack shall not be used where painting is required and may be used on exterior work only when approved and stained with a preservative type stain.

TABLE I. SPECIES AND GRADE TABLES

Grading Rules	Species	Choice	Clear	C Select	C & Better
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-- End of Section --

## SECTION 06650

SOLID POLYMER (SOLID SURFACING) FABRICATIONS  
10/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A136.1	(1992) Organic Adhesives for Installation of Ceramic Tile
ANSI Z124.3	(1995) Plastic Lavatories
ANSI Z124.6	(1997) Plastic Sinks

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 570	(1998) Water Absorption of Plastics
ASTM D 638	(1999) Tensile Properties of Plastics
ASTM D 696	(1998) Coefficient of Linear Thermal Expansion of Plastics Between Minus 30 degrees C and 30 degrees C
ASTM D 2583	(1995) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM G 21	(1996) Determining Resistance of Synthetic Polymeric Materials to Fungi
ASTM G 22	(1976; R 1996) Determining Resistance of Plastics to Bacteria

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1995) High Pressure Decorative Laminates
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## 1.2 GENERAL DESCRIPTION

Work in this section includes backsplashes and countertops (including vanity tops) utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Shop Drawings  
Installation

Shop Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work.

#### SD-03 Product Data

Solid polymer material; G  
Qualifications  
Fabrications; G

Product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer, joint adhesive, sealants, and heat reflective tape. Both the manufacturer of materials and the fabricator shall submit a detailed description of operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

#### SD-04 Samples

Material; G

A minimum 4 by 4 inch sample of each color and pattern for approval. Samples shall indicate full range of color and pattern variation. Approved samples shall be retained as a standard for this work.

Counter and Vanity Tops; G

A minimum 1 foot wide by 6 inch deep, full size sample for each type of counter top shown on the project drawings. The sample shall include the edge profile and backsplash as detailed on the project drawings. Solid polymer material shall be of a pattern and color as indicated on the drawings. Sample shall include at least one seam. Approved sample shall be retained as standard for this work.

#### SD-06 Test Reports

Solid polymer material

Test report results from an independent testing laboratory attesting that the submitted solid polymer material meets or exceeds each of the specified performance requirements.

#### SD-07 Certificates

Fabrications  
Qualifications

Solid polymer manufacturer's certification attesting to fabricator qualification approval.

SD-10 Operation and Maintenance Data

Solid polymer material  
Clean-up

A minimum of six copies of maintenance data indicating manufacturer's care, repair and cleaning instructions. Maintenance video shall be provided, if available. Maintenance kit for matte finishes shall be submitted.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall not be delivered to project site until areas are ready for installation. Materials shall be stored indoors and adequate precautions taken to prevent damage to finished surfaces. Protective coverings shall be provided to prevent physical damage or staining following installation, for duration of project.

1.5 WARRANTY

Manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat, shall be provided. Warranty shall provide for material and labor for replacement or repair of defective material for a period of ten years after component installation.

1.6 QUALIFICATIONS

To insure warranty coverage, solid polymer fabricators shall be certified to fabricate by the solid polymer material manufacturer being utilized. All fabrications shall be marked with the fabricator's certification label affixed in an inconspicuous location. Fabricators shall have a minimum of 5 years of experience working with solid polymer materials.

1.7 MOCK-UP

Prior to final approval of shop drawings, a full-size mock-up shall be provided of a typical vanity top and countertop where multiple units are required. The mock-up shall include all solid polymer components required to provide a completed unit. The mock-up shall utilize finishes in patterns and colors indicated on the drawings. Should the mock-up not be approved, the Contractor shall re-work or remake it until approval is secured. Rejected units shall be removed from the jobsite. Approved mock-up may remain as part of the finished work.

PART 2 PRODUCTS

2.1 MATERIAL

Solid polymer material shall be a homogeneous filled solid polymer; not coated, laminated or of a composite construction; meeting ANSI Z124.3 and ANSI Z124.6 requirements. Material shall have minimum physical and performance properties specified. Superficial damage to a depth of 0.01

inch shall be repairable by sanding or polishing. Material thickness shall be as indicated on the drawings. In no case shall material be less than 1/2 inch in thickness.

#### 2.1.1 Cast, 100 Percent Acrylic Polymer Solid Surfacing Material

Cast, 100 percent acrylic solid polymer material shall be composed of acrylic polymer, mineral fillers, and pigments and shall meet the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	5800 psi (min.)	ASTM D 638
Hardness	55-Barcol Impressor (min.)	ASTM D 2583
Thermal Expansion	.000023 in/in/F (max.)	ASTM D 696
Boiling water Surface Resistance	No Change	NEMA LD 3-3.05
High Temperature Resistance	No Change	NEMA LD 3-3.06
Impact Resistance (Ball drop)		NEMA LD 3-303
1/2" sheet	140", 1/2 lb ball, no failure	
3/4" sheet	200", 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G 21
Bacteria Growth	No Growth	ASTM G 22
Liquid Absorption (Weight in 24 hrs.)	0.1% max.	ASTM D 570
Flammability		ASTM E 84
Flame Spread	25 max.	
Smoke Developed	30 max	

#### 2.1.2 Material Patterns and Colors

Patterns and colors for all solid polymer components and fabrications shall be those indicated on the project drawings. Pattern and color shall occur, and shall be consistent in appearance, throughout the entire depth (thickness) of the solid polymer material.

#### 2.1.3 Surface Finish

Exposed finished surfaces and edges shall receive a uniform appearance. Exposed surface finish shall be matte; gloss rating of 5-20.

## 2.2 ACCESSORY PRODUCTS

Accessory products, as specified below, shall be manufactured by the solid polymer manufacturer or shall be products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.

### 2.2.1 Seam Adhesive

Seam adhesive shall be a two-part adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between solid polymer materials and components to create a monolithic appearance of the fabrication. Adhesive shall be approved by the solid polymer manufacturer. Adhesive shall be color-matched to the surfaces being bonded where solid-colored, solid polymer materials are being bonded together. The seam adhesive shall be clear or color matched where particulate patterned, solid polymer materials are being bonded together.

### 2.2.2 Panel Adhesive

Panel adhesive shall be neoprene based panel adhesive meeting ANSI A136.1, Underwriter's Laboratories (UL) listed. This adhesive shall be used to bond solid polymer components to adjacent and underlying substrates.

### 2.2.3 Silicone Sealant

Sealant shall be a mildew-resistant, FDA and UL listed silicone sealant or caulk in a clear formulation. The silicone sealant shall be approved for use by the solid polymer manufacturer. Sealant shall be used to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures.

### 2.2.4 Conductive Tape

Conductive tape shall be manufacturer's standard foil tape, 4 mils thick, applied around the edges of cut outs containing hot or cold appliances.

### 2.2.5 Insulating Felt Tape

Insulating tape shall be manufacturer's standard product for use with drop-in food wells used in commercial food service applications to insulate solid polymer surfaces from hot or cold appliances.

## 2.3 FABRICATIONS

Components shall be factory or shop fabricated to the greatest extent practical to sizes and shapes indicated, in accordance with approved Shop Drawings and manufacturer's requirements. Factory cutouts shall be provided for sinks, lavatories, and plumbing fixtures where indicated on the drawings. Contours and radii shall be routed to template, with edges smooth. Defective and inaccurate work will be rejected.

### 2.3.1 Joints and Seams

Joints and seams shall be formed between solid polymer components using

manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.

#### 2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish.

Edge shapes and treatments, including any inserts, shall be as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

#### 2.3.3 Counter and Vanity Top Splashes

Backsplashes and end splashes shall be fabricated from 1/2 inch thick solid surfacing material and shall be provided to dimensions and shapes as indicated on the drawings. Backsplashes and end splashes shall be provided for all counter tops and vanity tops. Backsplashes shall be shop fabricated and be permanently attached.

##### 2.3.3.1 Permanently Attached Backsplash

Permanently attached backsplashes shall be attached straight with seam adhesive to form a 90 degree transition.

##### 2.3.3.2 End Splashes

End splashes shall be provided loose for installation at the jobsite after horizontal surfaces to which they are to be attached have been installed.

#### 2.3.4 Counter and Vanity Tops

All solid surfacing, solid polymer counter top and vanity top components shall be fabricated from 1/2 inch thick material. Edge details, dimensions, locations, and quantities shall be as indicated on the Drawings. Counter tops shall be complete with 4 inch high, unless otherwise indicated on the drawings, permanently attached, 90 degree transition at all locations. Attach 2 inch wide reinforcing strip of polymer material under each horizontal counter top seam.

##### 2.3.4.1 Counter Top With Sink

###### A. Stainless Steel

Countertops with sinks shall include cutouts to template as furnished by the sink manufacturer. Manufacturer's standard sink mounting hardware for stainless steel, rimless undercounter supported installation shall be provided. Seam between sink and counter top shall be sealed with silicone sealant. Sink, faucet, and plumbing requirements shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

##### 2.3.4.2 Vanity Tops With Bowls

###### A. One-Piece Vanity Top and Bowl

One-piece vanity top and bowl fabrications shall be a standard pre-fabricated product provided by the solid polymer manufacturer. Each unit shall include a vanity top with integral backsplash and sink

bowl.

### 2.3.5 Solid Polymer Vanity Bowls

Solid polymer vanity bowls shall be a standard product of the solid polymer manufacturer, designed specifically to be installed in solid polymer vanity tops. Bowls shall be of the same polymer composition as the adjoining counter top. Bowl design shall support a seam adhesive flush installation method. Bowl dimensions shall be 14-11/16 inches wide by 10-7/8 inches front to back by 5 inches deep.

## PART 3 EXECUTION

### 3.1 COORDINATION

In most instances, installation of solid polymer fabricated components and assemblies will require strong, correctly located structural support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid polymer fabricator/installer and other trades to insure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of wall panels, countertops, shelving, and all other solid polymer fabrications to the degree and extent recommended by the solid polymer manufacturer. Contractor shall appropriate staging areas for solid polymer fabrications.

### 3.2 INSTALLATION

#### 3.2.1 Components

All components and fabricated units shall be installed plumb, level, and rigid. Field joints between solid polymer components to provide a monolithic appearance shall be made using solid polymer manufacturer's approved seam adhesives, with joints inconspicuous in the finished work. Metal sinks shall be attached to counter tops using solid polymer manufacturer's recommended clear silicone sealant and mounting hardware. Solid polymer bowls shall be installed using a color-matched seam adhesive.

Plumbing connections to sinks and lavatories shall be made in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

#### 3.2.2 Silicone Sealant

A clear, silicone sealant or caulk shall be used to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures. Sealant bead shall be smooth and uniform in appearance and shall be the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Bead shall be continuous and run the entire length of the joint being sealed.

#### 3.2.3 Plumbing

Plumbing connections to sinks and lavatories shall be made in accordance with Section 15400.

### 3.3 CLEAN-UP

Components shall be cleaned after installation and covered to protect against damage during completion of the remaining project items.

Components damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who shall approve estimate before repairs are made.

-- End of Section --

## SECTION 07110A

BITUMINOUS DAMPPROOFING  
09/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1187 (1997) Asphalt-Base Emulsions for Use as Protective Coatings for Metal

ASTM D 1227 (1995) Emulsified Asphalt Used as a Protective Coating for Roofing

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-07 Certificates

## Materials

Certificates attesting that the materials meet the requirements specified.

## 1.3 QUALIFICATIONS

Work shall be performed by skilled laborers thoroughly experienced in the type of bituminous dampproofing work specified to meet the requirements of the contract.

## 1.4 DELIVERY, STORAGE AND HANDLING

Dampproofing materials shall be delivered to the project site in the original sealed containers bearing the name of manufacturer, contents and brand name, and stored in a weathertight enclosure to prevent moisture damage and absorption. Dampproofing materials shall be protected from freezing. Asphalt shall be stored off the ground on pallets, and covered on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup; and therefore, shall not be used to cover dampproofing materials. Care shall be taken during storage to avoid separation or settlement of the emulsion components. Damaged or deteriorated materials shall be removed from the project site.

## PART 2 PRODUCTS

## 2.1 EMULSION-BASED ASPHALT DAMPPROOFING

### 2.1.1 Fibrated Emulsion-Based Asphalt

Fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1227 Type IV, asbestos-free, manufactured of refined asphalt, emulsifiers and selected clay, fibrated with mineral fibers. For spray or brush application, emulsion shall contain a minimum of 59 percent solids by weight, 56 percent solids by volume. For trowel application, emulsion shall contain a minimum of 58 percent solids by weight, 55 percent solids by volume.

### 2.1.2 Non-Fibrated Emulsion-Based Asphalt

Non-fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1187 Type II or ASTM D 1227 Type III, manufactured of refined asphalt, emulsifiers and selected clay. Asphalt shall contain a minimum 58 percent solids by weight, 55 percent solids by volume.

## PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces scheduled for bituminous dampproofing shall be prepared in accordance with dampproofing manufacturer's recommendations. Surface preparation shall be approved prior to dampproofing application.

#### 3.1.1 Protection of Surrounding Areas

Before starting the dampproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of asphalt onto other work. Drains and conductors shall be protected from clogging with asphalt.

#### 3.1.2 Masonry Surfaces

Surfaces shall be free of oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Mortar joints shall be flush and free of extraneous mortar and chipped or broken masonry.

### 3.2 APPLICATION OF BITUMINOUS DAMPPROOFING

#### 3.2.1 Emulsion-Based Asphalt

Emulsion-based asphalt dampproofing work shall not be performed in temperatures below 40 degrees F. Emulsions shall have a smooth and uniform consistency at time of application. Dampproofing materials shall be applied in two coats in addition to the primer coat in accordance with manufacturer's published instructions to produce a smooth uniform dry film of not less than 40 mils thick without voids or defects. Dull or porous spots shall be recoated. Dampproofing materials shall seal tightly around pipes and other items projecting through dampproofing. Rates of application shall be as follows:

a. Primer: (Non-Fibrated Dampproofing) 1/2 gallon per 100 square feet, cold-applied.

b. Fibrated Dampproofing: Minimum 3 gallons per 100 square feet, per coat cold-applied with spray, brush or trowel.

c. Non-fibrated Dampproofing: 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

### 3.3 CLEAN-UP

Surfaces of other work which are stained with dampproofing materials shall be cleaned with a cleaner recommended by dampproofing manufacturer.

### 3.4 PROTECTION

The completed dampproofing work shall be protected from damage during and after construction.

-- End of Section --

## SECTION 07131

## ELASTOMERIC SHEET WATERPROOFING

03/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 146	(1997) Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 412	(1998a) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 5385	(1993) Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes E1-2000 R(2000)
ASTM D 570	(1998) Water Absorption of Plastics
ASTM D 903	(1998) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM E 154	(1988; R 1999) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E 96	(2000) Water Vapor Transmission of Materials

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures:"

## SD-03 Product Data

Elastomeric waterproofing sheet material

Protection board

Primers, adhesives, and mastics

## SD-04 Samples

Corner and field condition

Attachment to existing waterproof sheeting.

#### SD-06 Test Reports

Elastomeric waterproofing sheet material

Certify compliance with performance requirements specified herein.

#### SD-08 Manufacturer's Instructions

Submit Manufacturer's material safety data sheets for primers, adhesives and mastics.

### 1.3 QUALITY ASSURANCE

#### 1.3.1 Shop Drawing Requirements

Include description and physical properties; termination details; application details; recommendations regarding shelf life, application procedures; requirements for protective covering; and precautions for flammability and toxicity.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver and store materials out of the weather, in manufacturer's original packaging with brand name and product identification clearly marked. Do not permit uncertified materials in the work area.

### 1.5 ENVIRONMENTAL CONDITIONS

Do not apply waterproofing during inclement weather or when there is ice, frost, surface moisture, or visible dampness on the surface to receive waterproofing and when ambient and surface temperatures are 40 degrees F or below. The restriction on the application of waterproofing materials when ambient and surface temperatures are below 40 degrees F will be waived if the Contractor devises a means, approved by the Contracting Officer, of maintaining the surface and ambient temperatures above 40 degrees F.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Provide one of the types of elastomeric waterproofing sheet material and related primers, adhesives, and mastics as specified herein. Ensure compatibility of waterproofing materials within a specific type, with each other, and with the materials on which they will be applied. Materials shall conform to the applicable performance requirements cited below when tested in accordance with the referenced ASTM publications.

### 2.2 COMPOSITE, SELF-ADHERING MEMBRANE SHEETING

Cold applied composite sheet consisting of rubberized asphalt and cross laminated, high density polyethylene film. Not less than 60 mils minimum thickness is required.

#### 2.2.1 Composite, Self-Adhering Sheeting Performance Requirements

- a. Tensile Strength, ASTM D 412, Die C: 250 psi minimum;
- b. Ultimate Elongation, ASTM D 412, Die C: 200 percent minimum;
- c. Water Vapor Transmission, ASTM E 96 80 Degrees F Permeance, Procedure B: 0.1 perm maximum;
- d. Pliability Degrees F, ASTM D 146: (180 Degrees Bend Over One Inch Mandrel): No cracks at minus -25 degrees F;
- e. Cycling Over Crack at Minus 15 Degrees F: Membrane is applied and rolled across two primed concrete blocks with no separation between blocks. Crack opened and closed from zero to 1/4 inch. No effect at 100 cycles;
- f. Puncture Resistance, ASTM E 154: 40 lb. minimum;
- g. Lap Adhesion at Minimum Application Temperature, ASTM D1876 Modified, 880 N/m (5 lbs/in.);
- h. Peel Strength, ASTM D 903: Modified, , 9 lbs/n;
- i. Resistance to Hydrostatic Head, ASTM D 5385:, , 231 ft of water
- j. Water Absorption, ASTM D 570; 0.1% maximum.

#### 2.2.2 Primer

Asphalt composition, ASTM D 41, or synthetic polymer in solvent as recommended by the membrane manufacturer.

#### 2.2.3 Mastic

Polymer modified asphalt in suitable solvent of trowel-grade consistency and as recommended by the membrane manufacturer.

#### 2.3 Protection Board

Provide protection board at backfilled locations that is compatible with the waterproofing membrane. Use a minimum 1/2 inch thick for bituminous - impregnated board, 1/8 inch thick for vertical and 1/4 inch for horizontal premolded bituminous protection board as recommended by the manufacturer.

### PART 3 EXECUTION

#### 3.1 VERIFICATION OF CONDITIONS

Before starting the work, verify that surfaces to be waterproofed are in satisfactory condition. Notify the Contracting Officer of defects or conditions that will prevent a satisfactory application. Do not start application until defects and conditions have been corrected.

#### 3.2 SURFACE PREPARATION

Ensure surfaces to be treated are clean, dry, smooth, and free from deleterious materials and projections. Thoroughly wet holes, joints, cracks, and voids in masonry or concrete with water and fill with Portland cement mortar, strike flush, and permit to dry. Cut off high spots or grind smooth. Finish top surfaces of projecting masonry or concrete ledges

below grade, except footings, to a steep bevel with Portland cement mortar. Sweep surfaces to be covered before applying waterproofing to remove dust and foreign matter. Cure concrete by a method compatible with the waterproofing system.

### 3.3 APPLICATION

Follow manufacturer's printed installation instructions. Provide at all elevator pits, all exterior walls below finish floor to footings on all junctures of reinforced gypsum sheathing to CMU and to bridge steel numbers that would otherwise be exposed to the cavity of an exterior wall. Provide elsewhere as indicated. Where indicated, mop continuous cant strips in place at vertical and horizontal corners before installing the waterproofing membrane. Do not use untreated wood or wood fiber cants. When using solvents, avoid prolonged contact with skin and breathing of vapor. Provide adequate ventilation. Carry waterproofing of horizontal surfaces up abutting vertical surfaces as indicated and adhere solid to the substrate. Avoid wrinkles and buckles in applying membrane and joint reinforcement.

- a. Self-Adhering Membrane: Apply composite, self-adhering membrane on surfaces primed at a uniform coverage rate in accordance with membrane manufacturer's printed instructions. Remove release sheet and apply with tacky surface in contact with dried primer.
- b. Protection: Protect membrane over horizontal surfaces from abnormal traffic during installation. Use only equipment with rubber tires. Provide walkway protection where heavy traffic from other trades is expected. Do not store material on membrane.

### 3.4 Composite, Self-Adhering Membrane

Lap sheets at edges and ends a minimum of 2 1/2 inches over the preceding sheet. All side laps shall be minimum 2 1/2 inches and end laps shall be 5 inches. Laps shall be self adhesive, mastic as per manufacturer's recommendation. Roll or firmly press to adhere membrane to substrate. Cover corners and joints with two layers of reinforcement by first applying a 12 inch width of membrane centered along the axis. Flash drains and projections with a second ply of membrane for a distance of 6 inches from the drain or projection. Finish exposed, terminated edges of membrane on horizontal or vertical surfaces with a trowelled bead of mastic. Apply mastic around edges of membrane, and drains and projections. Apply mastic at end of each work day.

### 3.5 PROTECTIVE COVERING

After installation has been inspected and approved by the Contracting Officer, apply a protective covering to the membrane waterproofing prior to backfilling. Protect vertical membrane waterproofing with a 1/2 inch minimum thickness of asphalt plank; 1/2 inch minimum thickness of fiberboard; or 1/8 inch minimum thickness of compatible water-resistant bitumen type protection board with edges abutting adjacent edges and exposed surfaces covered by a taping system recommended by manufacturer of protection board. Cover horizontal membrane waterproofing with similar protection board and Portland cement mortar not less than 3/4 inch thick; place uniformly and allow to set before installing subsequent construction.

-- End of Section --

## SECTION 07220A

ROOF INSULATION  
10/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 312	(2000) Asphalt Used in Roofing
ASTM D 4586	(1993; R 1999) Asphalt Roof Cement, Asbestos Free

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P9513	(1996) Loss Prevention Data for Roofing Contractors
FM P7825a	(1998) Approval Guide Fire Protection
FM P7825c	(1998) Approval Guide Building Materials

## UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(1999) Building Materials Directory
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Application of Insulation

Insulation manufacturer's recommendations for the application and installation of insulation.

## Inspection

The inspection procedure for insulation installation, prior to

start of roof insulation work.

### 1.3 STORAGE OF MATERIALS

Insulation materials shall be stored in accordance with manufacturer's instructions. Insulation, base sheet, and felt shall be kept dry at all times, before, during, and after delivery to the site and shall be stored in an enclosed building or in a closed trailer. Wet insulation, wet base sheet or wet felt shall be permanently removed from the site. Felts shall be stacked on end one level high. Felt rolls shall be maintained at a temperature above 50 degrees F for 24 hours immediately before laying.

### 1.4 FIRE CLASSIFICATION

Insulation shall have been tested as part of a roof construction assembly of the type used in this project, and the construction shall be listed as Fire-Classified in UL Bld Mat Dir or Class I in FM P7825a.

## PART 2 PRODUCTS

### 2.1 BITUMINOUS MATERIALS

Bituminous materials shall conform to the following requirements:

#### 2.1.1 Asphalt Bitumen

ASTM D 312, Type III or IV. Asphalt flash point, finished blowing temperature, and equiviscous temperature (EVT) for mop and for mechanical spreader application shall be indicated on bills of lading or on individual containers.

#### 2.1.2 Asphalt Cement

ASTM D 4586, Type I for surfaces sloped from 0 to 3 inches per foot; Type II for slopes greater than 3 inches per foot.

#### 2.1.3 Asphalt Primer

ASTM D 41.

### 2.2 INSULATION

Insulation shall be a standard product of the manufacturer and shall be factory marked with the manufacturer's name or trade mark, the material specification number, the R-value at 75 degrees F, and the thickness. Minimum thickness shall be as recommended by the manufacturer. Boards shall be marked individually. The thermal resistance of insulation shall be not less than the R-value shown on the drawings. The insulation manufacturing process shall not include chlorofluoro carbons (CFC) or formaldehydes. Contractor shall comply with EPA requirements in conformance with Section 01670 RECYCLED / RECOVERED MATERIALS. Insulation shall be one, or a combination of the following materials:

#### 2.2.1 Polyisocyanurate

ASTM C 1289, Type I, or ASTM C 1289 Type II, having minimum recovered material content of 9 percent by weight of the polyisocyanurate portion of the board.

### 2.3 FASTENERS

Fasteners shall be specifically designed screws and plates or spikes and plates of sufficient length to hold insulation securely in place. Fasteners shall conform to insulation manufacturer's recommendations except that holding power, when driven, shall be not less than 120 pounds each in steel deck. Fasteners for steel or concrete decks shall conform to FM P7825c for Class I roof deck construction, and shall be spaced to withstand an uplift pressure of 90 pounds per square foot.

### 2.4 WOOD NAILERS

Wood nailers shall conform to Section 06100 ROUGH CARPENTRY, including preservative treatment. Edge nailers shall be not less than nominal 6 inches wide and of thickness to finish flush with the top surface of the insulation. Surface mounted nailers shall be a nominal 3 inches wide by the full thickness of the insulation.

## PART 3 EXECUTION

### 3.1 COORDINATION REQUIREMENTS

Insulation and roofing membrane shall be finished in one operation up to the line of termination at the end of each day's work. Completed sections shall be glaze coated when more than one day is required to finish the roofing. Phased construction will not be permitted.

### 3.2 ENVIRONMENTAL CONDITIONS

The temperature of the roofing materials shall be as required by the manufacturer. Air temperature shall be above 40 degrees F and there shall be no visible ice, frost, or moisture on the roof deck when the insulation and roofing are installed. Wind conditions shall be suitable for installation of insulation: Wind chill may affect the proper application temperatures of materials; hot materials may be blown about, creating safety dangers; insulation boards may become difficult and hazardous to handle; wrappers, coverings, and other debris may become airborne, and possibly contaminate laps and seams.

### 3.3 SUBSTRATE PREPARATION

The substrate construction of any bay or section of the building shall be completed before insulation work is begun thereon. Vents and other items penetrating the roof shall be secured in position and properly prepared for flashing. Prior to application of vapor retarder or insulation, substrate joints shall be covered with a 4 inch strip of roofing felt, embedded in and coated with asphalt cement. Substrate surface shall be smooth, clean, and dry at time of application.

### 3.4 HEATING OF ASPHALT

Asphalt shall not be heated higher than 105 degrees F above the EVT or 50 degrees F below the flash point, or 525 degrees F, whichever is lower. EVT and flash point temperatures of asphalt in the kettle shall be conspicuously posted on the kettle. Kettle shall be provided with automatic thermostatic controls and an accurate thermometer. Kettle operators shall be in attendance at all times during heating to ensure that the maximum temperature is not exceeded. Asphalt shall be applied within a range of 25 degrees F below or above the EVT, or as specified by the

manufacturer. Application temperature shall be measured at the mop bucket or mechanical applicator. Asphalt at a temperature below this range shall be returned to the kettle. Flame-heated equipment shall not be placed on the roof.

### 3.5 INSTALLATION OF WOOD NAILERS

Nailers shall be secured to steel decks as indicated. Bolt anchors shall have nuts and washers countersunk, and bolts shall be cut flush with top of nailer. Powder-actuated fasteners, sized and spaced for nailer anchorage equivalent to that specified and indicated, may be used when approved. Surface mounted nailers shall be installed parallel with the roof slope and shall be spaced not over 47 inches face-to-face, except that where the insulation units are less than 47 inches in length the nailers shall be spaced to minimize cutting of the insulation.

### 3.6 APPLICATION OF INSULATION

Insulation shall be laid in two or more layers. Units of insulation shall be laid in courses parallel with the roof slope. End joints shall be staggered. Insulation shall be cut to fit neatly against adjoining surfaces. Joints between insulation boards shall not exceed 1/4 inch. Joints in successive layers shall be staggered with respect to joints of preceding layer. Where insulation is applied over steel deck, long edge joints shall continuously bear on surfaces of the steel deck. Insulation which can be readily lifted after installation is not considered to be adequately secured. Insulation shall be applied so that all roof insulation applied each day is waterproofed the same day. Phased construction will not be permitted. Application of impermeable faced insulation shall be performed without damage to the facing.

#### 3.6.1 Mechanical Fastening

On steel decks, for any slope exceeding 1/2 inch/foot, the first layer of insulation shall be mechanically fastened. Method of attachment shall be in accordance with recommendations of the insulation manufacturer and requirements specified.

#### 3.6.2 Steel Decks

All steel decks shall be insulated before receiving the structural standing seam metal roofing. Uninsulated steel decks shall have insulation applied to span the steel deck flutes and to act as an underlayment for the roof membrane. First layer of insulation on steel deck shall be compatible with mechanical fastening and shall meet fire resistant requirements.

#### 3.6.3 Installation

Except for the first layer on steel deck, insulation layers shall be laid in solid moppings of hot asphalt applied at a rate of at least 20 pounds per square. Asphalt shall not be applied further than one panel length ahead of roof insulation being installed. Where roof slopes are greater than 1/2 inch/foot, roof insulation shall be held in place by both asphalt mopping and mechanical fasteners. The edges of insulation boards adjoining vented nailers shall be kept free of asphalt.

#### 3.6.4 Protection Requirements

The insulation shall be kept dry at all times. Insulation boards shall not

be kicked into position. Exposed edges of the insulation shall be protected by cutoffs at the end of each work day or whenever precipitation is imminent. Cutoffs shall be 2 layers of bituminous-saturated felt set in plastic bituminous cement. Cutoffs shall be removed when work is resumed. Edges of insulation at open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, shall be protected until permanent roofing and flashing is applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces will not be permitted. Smooth, clean board or plank walkways, runways, and platforms shall be used, as necessary to distribute weight to conform to indicated live load limits of roof construction.

### 3.7 INSPECTION

The Contractor shall establish and maintain an inspection procedure to assure compliance of the installed roof insulation with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.
- b. Verification of certification, listing or label compliance with FM P9513.
- c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.
- d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.
- e. Inspection of mechanical fasteners; type, number, length, and spacing.
- f. Coordination with other materials, cants, sleepers, and nailing strips.
- g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.
- h. Installation of cutoffs and proper joining of work on subsequent days.
- i. Continuation of complete roofing system installation to cover insulation installed same day.

-- End of Section --

## SECTION 07416A

STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA Design Manual (2000) Aluminum Design Manual:  
Specification & Guidelines for Aluminum  
Structures

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec S335 (1989) Specification for Structural Steel  
Buildings - Allowable Stress Design,  
Plastic Design

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl (1996) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 792/A 792M (1999) Steel Sheet, 55% Aluminum-Zinc  
Alloy-Coated by the Hot-Dip Process

ASTM D 226 (1997a) Asphalt-Saturated Organic Felt Used  
in Roofing and Waterproofing

ASTM D 1308 (1987; R 1998) Effect of Household  
Chemicals on Clear and Pigmented Organic  
Finishes

ASTM D 1654 (1992) Evaluation of Painted or Coated  
Specimens Subjected to Corrosive  
Environments

ASTM D 2244 (1995) Calculation of Color Differences  
from Instrumentally Measured Color  
Coordinates

ASTM D 2247 (1999) Testing Water Resistance of Coatings  
in 100% Relative Humidity

ASTM D 2794 (1993; R 1999e1) Resistance of Organic  
Coatings to the Effects of Rapid  
Deformation (Impact)

ASTM D 3359 (1997) Measuring Adhesion by Tape Test

ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1999) Specular Gloss
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994e1) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E 1592	(1998) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G 154	(2000a e1) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

## AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1998) Minimum Design Loads for Buildings and Other Structures
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## 1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies all requirements contained herein and has been verified by load testing and independent design analysis to meet the specified design requirements.

## 1.2.1 Structural Standing Seam Metal Roof (SSSMR) System

The SSSMR system covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fascia, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, felt underlayments, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs; interior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

## 1.2.2 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing and designing SSSMR systems for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

### 1.2.3 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

## 1.3 DESIGN REQUIREMENTS

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

### 1.3.1 Design Criteria

Design criteria shall be in accordance with ASCE 7.

### 1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

### 1.3.3 Live Loads

#### 1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 300 pound concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

#### 1.3.3.2 Uniform Loads

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of 20 psf.

### 1.3.4 Wind Loads

The design wind uplift pressure for the roof system shall be as shown on the contract drawings. The design uplift force for each connection assembly shall be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

- a. Single fastener in each connection.....3.0
- b. Two or more fasteners in each connection...2.25

### 1.3.5 Thermal Loads

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of 104 degrees F during the life of the structure.

### 1.3.6 Framing Members Supporting the SSSMR System

Any additions/revisions to framing members supporting the SSSMR system to accommodate the manufacturer/fabricator's design shall be the Contractor's responsibility and shall be submitted for review and approval. New or revised framing members and their connections shall be designed in accordance with AISC ASD Spec S335. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180 of the span length.

### 1.3.7 Roof Panels Design

Steel panels shall be designed in accordance with AISI Cold-Formed Mnl. Aluminum panels shall be designed in accordance with AA Design Manual. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports. Deflection shall be calculated and measured along the major ribs of the panels.

### 1.3.8 Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 3/8 inch will be allowed when the supporting structural members are prepunched or predrilled.

## 1.4 PERFORMANCE REQUIREMENTS

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 30 inches. Test 2 shall simulate the interior condition with both ends free of crosswise restraint.

The maximum span length for the interior condition shall be 5.0 feet. External reinforcement, such as clamps on the ribs, shall not be installed to improve uplift resistance. Bolts through seams shall not be installed.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be

submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Standing Seam Metal Roof System; G, AE.

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

SD-03 Product Data

Design Analysis; G, AE.

Design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis shall include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and shall indicate how expected thermal movements are accommodated.

Qualifications

Qualifications of the manufacturer and installer.

SD-04 Samples

Roof Panels; G, AE.

One piece of each type to be used, 9 inches long, full width.

Factory Color Finish; G, AE.

Three 3 by 5 inches samples of each type and color.

SD-06 Test Reports

Test Report for Uplift Resistance of the SSSMR; G, AE.

The report shall include the following information:

- a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.
- b. Details of the anchor clip, dimensions, and thickness.
- c. Type of fasteners, size, and the number required for each connection.
- d. Purlins/subpurlins size and spacing used in the test.

e. Description of the seaming operation including equipment used.

f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.

g. Any additional information required to identify the SSSMR system tested.

h. Signature and seal of an independent registered engineer who witnessed the test.

#### SD-07 Certificates

Structural Standing Seam Metal Roof System; G, AE.

a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.

b. Certification that materials used in the installation are mill certified.

c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.

d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.

e. Certification of installer. Installer certification shall be furnished.

f. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties, and the manufacturer's 20-year system weathertightness warranty.

#### 1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

#### 1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

##### 1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum

basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, and curbs; interior or exterior gutters; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects.

This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

#### 1.7.2 Manufacturer's Material Warranties.

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum-zinc alloy coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

c. A roofing system manufacturer's 20 year, non-prorated, system weathertightness warranty.

## 1.8 COORDINATION MEETING

A coordination meeting shall be held 30 days prior to the first submittal, for mutual understanding of the Structural Standing Seam Metal Roof (SSSMR) System contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roof system manufacturer, the roofing supplier, the erector, the SSSMR design engineer of record, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

## PART 2 PRODUCTS

### 2.1 ROOF PANELS

Panels shall be steel fabricated from tension-leveled coil stock. Panels shall have two stiffening ribs or flutes between seams and shall have a factory color. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 30 feet. When length of run exceeds 30 feet and panel laps are provided, each sheet in the run shall extend over three or more supports. Sheets longer than 100 feet may be furnished if approved by the Contracting Officer. Standing seams shall be spaced 16 inches on centers. Height of standing seams shall be not less than 2-1/16 inches. Seams of panels shall be so configured that when adjacent sheets are installed, the seams shall be sealed utilizing mechanical seamers. The profile of the standing seams shall be Maxima 216 bead pencil rib as manufactured by McElroy Metals, Inc. or approved equal (of similar profile).

#### 2.1.1 Steel Panels

Steel panels shall be not lighter than 22 gauge; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 55 coating. Panels shall be within 95 percent of reported tested thickness as noted in wind uplift resistance testing required in paragraph PERFORMANCE REQUIREMENTS.

### 2.2 CONCEALED ANCHOR CLIPS AND BEARING PLATES

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads. Provide minimum 16 gauge hot dip galvanized steel bearing plates at all anchor clips as indicated. All fasteners shall extend through the insulation and be secured into the structural metal decking.

### 2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Die cast metal closures shall be installed with double bead tape sealant and fasteners that stitch the panel to a 16 gage preformed backer plate to ensure a positive compression of the tape sealant. The use of a continuous angle butted to the panel ends to form a closure will not be allowed. Provide continuous

corrugated polypropylene vent strips where indicated.

## 2.4 FASTENERS

Fasteners shall extend through the insulation and secured into the structural metal decking. Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 750 pounds per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed fasteners shall not be used.

### 2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14. Actual screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

### 2.4.2 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 1/4 inch diameter. Blind (pop) rivets shall be not less than 9/32 inch minimum diameter.

## 2.5 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated on the drawings. The exterior coating shall be a nominal 2 mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than 1.0 mil thickness. The interior color finish shall consist of a 0.2 mil thick prime coat. The exterior color finish shall meet the test requirements specified below.

### 2.5.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 21/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

### 2.5.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

### 2.5.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM G 154, test condition UVA-340 lamp, 8h UV at 60 degrees C followed by 4h CON at 45 degrees C for 12 total exposure hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating with an adhesion rating less than 4B when tested in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

### 2.5.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

### 2.5.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

### 2.5.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 50 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

### 2.5.7 Specular Gloss

Finished roof surfaces shall have a specular gloss value of 10 or less at an angle of 85 degrees when measured in accordance with ASTM D 523.

### 2.5.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

## 2.6 UNDERLAYMENTS

### 2.6.1 Felt Underlayment

Felt underlayment shall be No. 15 felt in accordance with ASTM D 226, Type II.

### 2.6.2 Rubberized Underlayment

Rubberized underlayment shall be equal to "Ice and Water Shield" as manufactured by Grace Construction products, "Winterguard" as manufactured by CertainTeed Corporation, or "Weather Watch Ice and Water Barrier" as

manufactured by GAF Building Materials Corporation.

### 2.6.3 Slip Sheet

Slip sheet shall be 5 pounds per 100 sf rosin sized unsaturated building paper.

### 2.7 BUILT-IN GUTTERS

Built-in gutters shall be fabricated or 18 gauge galvanized steel. Built-in gutters shall be formed as indicated. Roof drain stubs shall be fabricated of 16 gauge galvanized steel.

### 2.8 MEMBRANE FOR GUTTER LINING

Membrane shall conform to ASTM D 4637, Type EPDM, Grade 1; Class U, 60 mil thickness.

### 2.9 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

### 2.10 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

### 2.11 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

### 2.12 PREFABRICATED CURBS AND EQUIPMENT SUPPORTS

Prefabricated curbs and equipment supports shall be of structural quality, hot-dipped galvanized or galvanized sheet steel, factory primed and prepared for painting with mitered and welded joints. Integral base plates and water diverter crickets shall be provided. Minimum height of curb shall be 8 inches above finish roof. Curbs shall be constructed to match roof slope and to provide a level top surface for mounting of equipment. Curb flange shall be constructed to match configuration of roof panels. Curb size shall be coordinated, prior to curb fabrication, with the mechanical equipment to be supported. Strength requirements for equipment supports shall be coordinated to include all anticipated loads. Flashings shall not be rigidly attached to underline structure.

### 2.13 SNOW GUARDS

Snow guards shall be a clear polycarbonate polymer material made specifically by a manufacturer for the suspension of snow and ice to remain on the roof to gradually melt therefore minimizing the unexpected snow and

ice masses from falling from the roof or damaging gutter systems. Snow guards shall be adhered to the roofing panels by use of liquid adhesive or double coated acrylic foam tape when acceptable to the manufacturer. When using tape, the installer shall provide tape primer.

#### 2.14 STRAINERS

Strainers shall be pressure fitting, stainless steel, bulb shaped fabricated of minimum 12 gauge wire. Wire shall be specially bent to pressure fit into roof leader opening without use of mechanical tools.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site. Provide expansion joints as recommended by the manufacturer.

##### 3.1.1 Field Forming of Panels for Unique Area

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

##### 3.1.2 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings.

##### 3.1.3 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the structural framing members. Attachment to the substrate (when provided) or to the metal deck is not permitted. The maximum distance, parallel to the seams, between clips shall be 30 inches on center at the corner, edge, and ridge zones, and 5 feet maximum on centers for the remainder of the roof.

#### 3.1.4 Underlayment

Provide felt underlayment and slip sheet (rosin sized building paper) over the substrate (rigid roof insulation) under all areas of the metal roofing.

The slip sheet shall be laid on top of the felt underlayment. In addition, provide rubberized underlayment between the substrate and the felt underlayment in the following locations:

- a. Valley, extend six feet on each side of the valleys, continuous.
- b. Roof penetrations, extend minimum of 36 inches around all sides of penetrations.
- c. Eaves and rakes, extend minimum of 36 inches, continuous

All underlayments shall be installed so that successive strips overlap the next lower strip in shingle fashion. Underlayments shall be installed in accordance with the manufacturer's written instructions. The underlayments shall ensure that any water that penetrates below the metal roofing panels will drain outside of the building envelope.

#### 3.2 BASE FLASHING

Base flashing shall be provided in configuration as indicated. Base flashing shall be set in a full bed of plastic cement configured to the metal roofing profile and receive a full bed of sealant at all junctures to adjacent materials. Material and finish shall match that of metal roofing.

#### 3.3 COUNTERFLASHING

Counterflashing shall be two piece spring type as indicated.

Counterflashing shall be provided over base flashing. Counterflashing shall be factory formed to provide spring action against the base flashing.

Counterflashing for embedment into masonry shall be coated as recommended by the manufacturer for metals in contact with masonry. Counterflashing shall be lapped and sealed in a full bed of plastic cement. Material and finish shall match that of the metal roofing.

#### 3.4 STEP FLASHING

Step flashing shall be installed where sloping roofs abut vertical surfaces. Separate pieces of overlapping base flashing and counterflashing shall be provided as indicated and as recommended by the metal roofing manufacturer.

#### 3.5 BUILT-IN GUTTERS

Built-in gutters shall be secured to wood blocking and framing with self tapping screws 12 inches on center and secured into the metal roof deck with deck fasteners with washers at 12 inches on center. Built-in gutter shall be provided with bayonette type expansion joints set in full bed of sealant where indicated on plan. Gutter sections shall have all splices, seams, junctures, and continuations fully welded. Roof drain stubs shall

be 16 gauge galvanized steel formed and welded to size of rain leader indicated on the plumbing drawings. The roof drain stub shall be comprised of the roof drain diameter stub and setting plate and the setting plate shall be set in a full bed of mastic to the top surface of the gutter bottom. The gutter after being fully formed shall be lined with 60 mil EPDM fully adhered to the gutter box. All lap seams in the EPDM shall be provided a 6 inch fully adhered strip of EPDM centered over the lap. At roof drain locations a second layer of EPDM shall be adhered to the top of the base layer of EPDM and shall be formed and extended into the roof drain as indicated.

### 3.6 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

FACILITY DESCRIPTION \_\_\_\_\_

BUILDING NUMBER: \_\_\_\_\_

CORPS OF ENGINEERS CONTRACT NUMBER: \_\_\_\_\_

CONTRACTOR

CONTRACTOR: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

OWNER

OWNER: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONSTRUCTION AGENT

CONSTRUCTION AGENT: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY \_\_\_\_\_ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON \_\_\_\_\_ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

\_\_\_\_\_  
(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).
2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.
3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.
4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.
5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.
6. THIS WARRANTY APPLIES TO THE SSSMR SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.
7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

\*\*

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

\*\*REPORTS OF LEAKS AND SSSMR SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

## SECTION 07420

COMPOSITE ALUMINUM PANEL SYSTEM  
05/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Specification for Stainless and Heat-Resisting Chromium - Nickel Steel, Plate, Sheet and Strip
ASTM B 177	(1993) Guide for Chromium Electroplating on Steel for Engineering Use
ASTM D 714	(1994) Test Method for Evaluating Degree of Blistering of Paints
ASTM D 822	(1996) Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus
ASTM D 1037	(1996a) Test Methods for Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D 2247	(1996) Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity
ASTM E 84	(1996a) Test Method for Surface Burning Characteristics of Building Materials
ASTM E 283	(1991) Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(1996) Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference
ASTM E 331	(1996) Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference

## MILITARY SPECIFICATION (MS)

MIL-C-18480

Coating Compound, Bituminous Solvent, Coat  
Tar Base

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Panels; G, AE.

Metal accessories; G, AE.

Submit fabrication and erection drawings of the composite aluminum panel system. The shop drawings shall indicate in detail all parts of the system including elevations, full-size sections, framing, jointing, panels, types and thickness of metal, flashing and coping details, field connection, weep and drainage system, finishes and sealing methods.

## SD-03 Product Data

Panels; G, AE.

Submit manufacturer's data, including descriptive literature, detail specifications, performance test data, and instruction for application, installation, cleaning, and maintenance.

## SD-04 Samples

Panels; G, AE.

Metal accessories; G, AE.

Label and submit samples in duplicate unless otherwise specified. Metal samples shall be complete with color and finish as indicated. Submit two samples of a typical assembly detail 18 inches by 18 inches. Submit three samples of the actual panel material, 6 inches by 6 inches minimum.

## SD-06 Test Reports

Certified test reports.

In addition to certified reports of tests specified herein for the panel system or components under the paragraph titled "Tests," submit certified test reports for the following:

Joint sealants test as required by the applicable publications referenced.

Preformed compression gaskets and seals tests required by AAMA Spec. SF-1.

Preformed lock-strip type gasket tests required by ASTM C 542, as modified herein.

## SD-07 Certificates

## Materials

Submit manufacturer's certificate of conformance for all materials.

### 1.3 TESTS

Submit copies of all certified test reports.

#### 1.3.1 Deflection and Structural Test

No composite aluminum panel shall deflect, in direction normal to the plane of the wall, more than 1/240 of its clear span or 1/4 inch, whichever is less, when tested in accordance with ASTM E 330, except that when a plastered surface will be affected when the member is installed in the project, the deflection shall not exceed 1/360 of the span. No framing member shall have a permanent deformation in excess of 0.2 percent of its clear span when tested in accordance with ASTM E 330 at 1.5 times the design wind pressures specified hereinafter.

#### 1.3.2 Water Penetration Test

No water penetration shall occur when the wall is tested in accordance with ASTM E 331, at a differential static test pressure of 20 percent of the inward acting design wind pressure as specified hereinafter but not less than 4 psf. Make provisions in the wall construction for adequate drainage to the outside of water leakage or condensation that occurs within the outer face of the wall.

#### 1.3.3 Air Infiltration Test

Air infiltration through the wall, when tested in accordance with ASTM E 283, shall not exceed 0.06 cfm per square foot of fixed wall area.

#### 1.3.4 Delamination Test

Bonded aluminum faced panels shall show no evidence of delamination, warpage or other deterioration or damage when subjected to the six "Accelerated Aging Cycles" specified in ASTM D 1037.

#### 1.3.5 Flame Spread Tests

Insulation field applied in conjunction with wall system shall have a flame spread rating not exceeding 75 and a smoke developed rating not exceeding 150 when tested in accordance with ASTM E 84, except as shown otherwise herein.

### 1.4 ALUMINUM PANEL SYSTEM

Provide the system complete with framing, mullions, panels, coping, recesses, sealants, fasteners, anchors, accessories, and concealed auxiliary members and attachment devices for securing the wall to the structure as specified or indicated. Materials and finishes shall conform to the paragraph titled "Materials" hereinafter.

#### 1.4.1 Components

Composite aluminum panels system components shall be provided by one manufacturer or fabricator.

#### 1.4.2 Design

Composite aluminum panel system shall generally be unit system type with joints as indicated. Accessories of the wall system directly incorporated, and adjacent to contiguous related work, shall be fully coordinated to provide for materials compatibility, deflection limitations, thermal movements and clearances and tolerances as indicated or specified. Where the manufacturer or fabricator of the system has specified written recommendations or instructions regarding accessories or related contiguous work, these recommendations and instructions shall be followed unless specified or indicated otherwise herein.

#### 1.4.3 Delivery and Storage

Inspect materials delivered to the site for damage; unload and store with a minimum of handling. Storage spaces shall be dry locations with adequate ventilation, free from heavy dust, not subject to combustion products or sources of water, and shall permit easy access for inspection and handling.

Store material neatly on the floor, properly stacked on non-absorptive strips or wood platforms. Store panels, and other fabricated members on lower end or edge in upright position with non-absorptive strips between adjacent parts. Protect, panel and other fabricated members with clean, loose-fitting tarpaulins or plastic sheet covers hung on a temporary frame so that air can circulate between parts to avoid condensation. Do not store aluminum with applied protective tape or other strippable coatings where exposed to sunlight or subject to climatic changes.

#### 1.4.4 Protective Covering

Prior to shipment from the factory, finished surfaces of aluminum shall receive a protective covering. Covering shall not chip, peel, or flake due to temperature or weather, shall protect against discoloration and surface damage from transportation, and storage, and shall be resistant to alkaline mortar and plaster. Coverings shall be adhesive paper, waterproof tape, or strippable plastic. Aluminum surfaces that will be in contact with sealants after installation shall not receive protective covering.

#### 1.4.5 Thermal Movement

Fabricate, assemble, and erect the system with adequate allowances for expansion and contraction of components and fastenings to prevent buckling damage, joint seal failure, undue stress on fastenings or other detrimental effects. For design purposes, the provisions for thermal movement shall be based on assumed ambient temperature range of from 0 degrees F to 95 degrees F.

#### 1.4.6 Tolerances

Permissible tolerances in the building frame and other work adjacent to the system shall be indicated or stated in other sections of this specification. Design and erect the system to accommodate these tolerances. Provide aluminum faced plastic panel wall within the following tolerances:

##### 1.4.6.1 Maximum Variation from Plane or Location Shown on Approved Shop Drawings

1/8 inch per 12 feet of length up to not more than 1/4 inch in any total

length.

#### 1.4.6.2 Maximum Offset from True Alignment Between Two Identical Members Abutting End to End in Line

1/16 inch.

#### 1.4.7 Structural Requirements

Design the system to withstand the indicated wind and concentrated loads, and the following wind loads acting normal to the plane of the wall: 30 psf acting inward, and the same load outward. On corner areas, extending 6 feet from the building corners, on all facades, the outward-acting (negative) design load shall be increased to 60 pounds per square foot.

#### 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a three year period shall be provided.

### PART 2 PRODUCTS

#### 2.1 PANELS

Panels shall be fabricated of 1/4 inch thick aluminum faced extruded thermoplastic low density polyethylene sheets as specified. Panel shall have aluminum angle reinforcements at all bends.

##### 2.1.1 Bonded Panels

Panels shall be sandwich type, aluminum faced on both the side that will be exposed to view after installation and on the side that will not be exposed. Composition of bonded panel shall be outer aluminum 5205 alloy sheet of 0.020 thickness and an inner aluminum 5205 alloy sheet of 0.020 thickness sandwiching a core of extruded thermoplastic low density polyethylene formed in a continuous process with no glues or adhesives between dissimilar materials.

##### 2.1.2 Metal Accessories

Provide metal accessories including flashings and closures, as required in connection with the system. Fabricate accessories of sizes and shapes indicated from similar materials and finish as specified for the system, except as otherwise specified.

#### 2.2 MATERIALS

Aluminum shall be free from defects impairing strength or durability of surface finish. Standard alloys shall conform to standard and designations of The Aluminum Association's Standard and Data. Special alloys shall conform to standards and designations recommended by the manufacturer for the purpose intended.

Aluminum extrusions used as reinforcing members in the system shall have a minimum ultimate tensile strength of 22,000 psi and a minimum yield strength of 16,000 psi.

##### 2.2.1 Stainless Steel

Stainless steel shall conform to ASTM A 167, type 302 or 304, and have finish in accordance with the NAAMM Metal Finishes Manual as follows:

Stainless steel used for concealed flashings, shall be dead soft fully annealed and have a 2D finish.

Stainless steel used for exposed work shall have No. 4 finish to match approved sample.

#### 2.2.2 Metal Fasteners

Metals used for fasteners shall be chemically and galvanically compatible with contiguous materials. All screws, bolts, nuts, washers shall be stainless steel throughout wall system.

#### 2.2.3 Joint Sealants and Accessories

Joint sealant material shall conform to Section 07900 JOINT SEALING. Under normal application conditions, sealing compounds shall be non-toxic. Do not use sealants or components outdated as indicated by the manufacturer's designated shelf life. Sealing compounds shall be a single component silicone rubber base compound, unless specified or noted otherwise. Color of sealing compounds shall be the manufacturer's standard colors as closely matching the adjacent surfaces as possible.

#### 2.2.4 Finish

All exposed to view surfaces of panels and accessories shall receive a coil coated silicon modified polyester finish in color as indicated. Coating thickness shall be not less than 1.0 mil. The coating shall comply with the following requirements:

##### 2.2.4.1 Humidity Resistance

- a. Test Method ASTM D 714 and ASTM D 2247.
- b. No formation of blisters when subjected to condensing water fog at 95 degrees F for 1000 hours.

##### 2.2.4.2 Salt Spray Resistance

- a. Test Method: ASTM B 177; expose single coat system to 1000 hours, using 5 percent NaCl solution.
- b. Corrosion creepage from scribe line: 1/16 inch.
- c. No blistering or pinholing allowed.

##### 2.2.4.3 Weather Exposure

- a. Outdoor:
  - (1) 141A/6160; one year exposure at 45 degree angle, facing south in Miami, Florida.
  - (2) No checking, crazing, adhesion loss.
- b. Accelerated:

(1) ASTM D 822, 1000 hours in Atlas Type D.M.S. Weatherometer; using cycle or 102 minutes light and 18 minutes diminished light and demineralized water.

(2) No checking, crazing, adhesion loss.

c. Chemical Resistance:

(1) 24 hour immersion in mineral spirits, 0.5 percent Tide solution, 2.0 percent trisodium phosphate and 2.0 percent soap solution. Allow 24 hour recovery period before evaluation.

(2) No loss of adhesion or gloss and no color change.

## 2.3 FABRICATION

### 2.3.1 Composite Aluminum Panel System Components

The composite aluminum panel system components shall be of the materials and thickness specified. The details indicated are representative of the required design and profiles. Acceptable designs may differ from that shown in the proposed system components provided that they conform to the limiting dimensions indicated and the requirements specified herein. Anchorage devices shall permit adjustment in three directions. Exposed fastenings used on finished surfaces shall be stainless steel, flat head, or bolts. Exposed fastenings shall be avoided.

### 2.3.2 Ventilation and Drainage

Provide a system of internal ventilation drainage by weeps or by the principles of pressure equalization in the system to ventilate the wall internally and to discharge condensation and water leakage to exterior as inconspicuously as possible. Flashings and other materials used internally shall be non-staining, non-corrosive, and non-bleeding.

### 2.3.3 Protection and Treatment of Metals

#### 2.3.3.1 General

Before leaving the shop, remove from metal surfaces, lubricants used in the fabrication and clean off other extraneous material. Protect exposed surfaces during fabrication, transportation, and erection against scratches, splashes, mortar, paint or other potential defacements as herein specified.

#### 2.3.3.2 Galvanic Action

Provide protection against galvanic action whenever dissimilar metals are in contact, except in the case of aluminum in permanent contact with stainless steel. Provide this protection by painting the contact surfaces with a coat of heavy-bodied bituminous paint conforming to Mil Spec. MIL-C-18480 or by the application of an appropriate calking material or non-absorptive, non-corrosive, and non-staining, tape or gasket between the contact surfaces. If painting is used to avoid contact of aluminum with dissimilar metals, paint only the dissimilar metal.

#### 2.3.3.3 Protection for Aluminum

Protect aluminum which is placed in contact with masonry, lime mortar,

concrete, or plaster with a heavy coat of alkali-resistant bituminous paint conforming to Mil. Spec. MIL-C-18480. Where aluminum is contacted by absorptive materials subject to repeated wetting or treated with a preservative noncompatible with aluminum, apply two coats of aluminum paint to such materials and seal joints with an approved caulking compound.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

The installation and erection of the composite aluminum panel system and all components shall be performed under the direct supervision of and in accordance with the approved recommendations and instructions of the system manufacturer or fabricator, except as otherwise specified or indicated. Erect the members and components plumb and true in proper alignment and in correct relationship to the work of other trades and the established lines and grades indicated. Install components, panels, sealants, and accessories as specified herein for each applicable component.

##### 3.1.1 Sealed Joints

Before sealing operations are started, make a sample of each type of joint where directed. The samples shall show the materials, workmanship, bond, and color of the sealant material, as specified for the work. The materials, workmanship, bond, and color of the sealant work throughout the project shall match that of the approved sample joints.

##### 3.1.2 Anchorage

Anchor the system to the structure in accordance with the details indicated and the shop drawings. After the wall is properly positioned, secure adjustable anchorage connections by welding or bolting as indicated and specified.

##### 3.1.3 Bench Marks and Reference Points

Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenience points on each floor level. Should any error or discrepancy be discovered in location of the marks, stop erection work in that area until discrepancies have been corrected.

##### 3.1.4 Verifying Conditions and Adjacent Surfaces

After establishment of lines and grades and prior to installation, examine structural elements over which the construction is to be applied or is otherwise dependent upon. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between the panel system and structural frames and other permissible dimensional tolerances in the building. Where previously placed related work, dimensions, or other existing conditions will prevent the satisfactory execution of the work or endanger its permanency, stop the succeeding work until the unsatisfactory conditions have been corrected.

#### 3.2 JOINT SEALANTS

Joint sealants shall be installed in accordance with Section 07900 JOINT SEALING.

#### 3.3 CLEANING AND PROTECTION

### 3.3.1 Metal Surfaces

Aster installation, protect windows, panels and other exposed wall surfaces from disfiguration, contamination, contact with harmful materials and from other construction hazards that will interfere with their operation or damage their appearance or finish. Protection methods shall be in accordance with recommendations of the manufacturers of the products or of the respective trade association. Remove paper or tape factory applied on metal surfaces for protection during shipping or handling immediately after installation. Clean metal surfaces in connection with the wall of mortar, plaster, paint smears of sealants and other foreign matter to present a neat appearance and prevent fouling of operation. In addition, wash surfaces off with a stiff fiber brush, soap and water, and thoroughly rinse. All surfaces stained or discolored, during contract operations shall be cleaned or have finish restored in accordance with the recommendations of the manufacturer of the products involved.

-- End of Section --

## SECTION 07600A

SHEET METALWORK, GENERAL  
11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 209	(2000) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(2000) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 32	(1996) Solder Metal
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 2822	(1991; R 1997e1) Asphalt Roof Cement
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993; R 1999) Asphalt Roof Cement, Asbestos Free

## INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)
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## SHEET METAL &amp; AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(1993; Errata; Addenda Oct 1997) Architectural Sheet Metal Manual
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## 1.2 GENERAL REQUIREMENTS

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall

allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Sheet metalwork associated with roofing is specified in Section 07416A, STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in Section 15895, AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Materials; G

Drawings of sheet metal items showing weights, gauges or thicknesses; types of materials; expansion-joint spacing; fabrication details; and installation procedures.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet-storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, ventilated areas until immediately before installation.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by SMACNA Arch. Manual for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements specified below and to the thicknesses and configurations established in SMACNA Arch. Manual. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

#### 2.1.1 Accessories

Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided.

#### 2.1.2 Aluminum Extrusions

ASTM B 221, Alloy 6063, Temper T5.

#### 2.1.3 Bituminous Cement

Type I asphalt cement conforming to ASTM D 2822 or ASTM D 4586. For coal tar roofing; coal tar cement conforming to ASTM D 4022.

#### 2.1.4 Sealant

Unless otherwise specified, sealant shall be an elastomeric weather resistant sealant as specified in Section 07900 JOINT SEALING.

#### 2.1.5 Fasteners

Fasteners shall be compatible with the fastened material and shall be the type best suited for the application.

#### 2.1.6 Felt

ASTM D 226, Type I.

#### 2.1.7 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized, clear, form, alloy, and temper appropriate for use, .032 inch thick minimum.

#### 2.1.8 Copper

ASTM B 370, Temper H 00, 16 ounces per square foot minimum.

#### 2.1.9 Stainless Steel

ASTM A 167, Type 302 or 304; fully annealed, dead soft temper, .032 inch thick minimum.

#### 2.1.10 Solder

ASTM B 32, 95-5 tin-antimony.

#### 2.1.11 Through-Wall Flashing

- a. Electro-sheet copper not less than 5 ounces, factory coated both sides with acid- and alkali-resistant bituminous compound not less than 6 ounces per square foot or factory covered both sides with asphalt-saturated cotton fabric, asphalt saturated glass-fiber fabric, or with 40 pound reinforced kraft paper bonded with asphalt.

#### 2.1.12 Louver Screen

Type I commercial bronze insect screening conforming to ISWA IWS 089.

### PART 3 EXECUTION

#### 3.1 PROTECTION OF ALUMINUM

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods:

##### 3.1.1 Paint

Aluminum surfaces shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint as specified in

Section 09900 PAINTING, GENERAL.

### 3.1.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and cemented to the aluminum surface using a cement compatible with aluminum.

## 3.2 CONNECTIONS AND JOINTING

### 3.2.1 Soldering

Soldering shall apply to copper, and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a water solution of washing soda and rinsed with clean water.

### 3.2.2 Riveting

Joints in aluminum sheets 0.040 inch or less in thickness shall be mechanically made.

### 3.2.3 Seaming

Flat-lock and soldered-lap seams shall finish not less than 1 inch wide. Unsoldered plain-lap seams shall lap not less than 3 inches unless otherwise specified. Flat seams shall be made in the direction of the flow.

## 3.3 CLEATS

A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints of cleats shall be spaced approximately 1/8 inch apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry.

## 3.4 FLASHINGS

Flashings shall be installed at locations indicated and as specified below. Sealing shall be according to the flashing manufacturer's recommendations.

### 3.4.1 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. The flashing shall be laid with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing shall not extend further into the masonry backup wall than the first mortar joint. Joints in flashing shall be lapped and sealed. Flashing shall be one piece for lintels and sills.

#### 3.4.1.1 Lintel Flashing

Lintel flashing shall extend the full length of lintel. Flashing shall extend through the wall one masonry course above the lintels and shall be bent down over the vertical leg of the outer steel lintel angle not less than 2 inches, or shall be applied over top of masonry and precast concrete lintels. Bedjoints of lintels at control joints shall be underlaid with sheet metal bond breaker.

#### 3.4.1.2 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 4 inches beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

#### 3.5 INSTALLATION OF LOUVERS

Louvers shall be rigidly attached to the supporting construction. The installation shall be rain-tight. Louver screen shall be installed as indicated.

#### 3.6 CONTRACTOR QUALITY CONTROL

The Contractor shall establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.
- b. Verification of compliance of materials before, during, and after installation.
- c. Inspection of sheet metalwork for proper size and thickness, fastening and joining, and proper installation.

The actual quality control observations and inspections shall be documented and a copy of the documentation furnished to the Contracting Officer at the end of each day.

-- End of Section --

## SECTION 07810A

SPRAY-APPLIED FIREPROOFING  
07/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2794	(1999) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 4060	(1995) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM E 119	(2000) Fire Tests of Building Construction and Materials
ASTM E 605	(1993; R 1996) Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E 736	(1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E 759	(1992; R 1996) Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 760	(1992; R 1996e1) Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 761	(1992) Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 859	(1993) Air Erosion of Sprayed Fire-Resistive Materials (SFRMS) Applied to Structural Members
ASTM E 937	(1993) Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E 1042	(1992; R 1997e1) Acoustically Absorptive Materials Applied by Trowel or Spray
ASTM G 21	(1996) Determining Resistance of Synthetic

## Polymeric Materials to Fungi

## UNDERWRITERS LABORATORIES (UL)

UL 263 (1997; Rev thru Jun 1998) Fire Tests of Building Construction and Materials

UL Fire Resist Dir (1999) Fire Resistance Directory (2 Vol.)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Fireproofing Material

Data identifying performance characteristics of fireproofing material. Data shall include recommended application requirements and indicate thickness of fireproofing that must be applied to achieve each required fire rating.

## SD-04 Samples

## Spray-Applied Fireproofing

One sample panel, 18 inches square, for each specified type of fireproofing. Also, a designated sample area of not less than 100 square feet shall be prepared. Sample area shall be representative of typical installation of fireproofing including metal decks, beams, columns and attachments. Equipment, materials and procedures used in the sample area shall be the same as, or representative of, that to be used in the work. The sample area shall be approved prior to proceeding with fireproofing work in any other area. The approved sample area shall be used as a reference standard for applied fireproofing material. Sample area shall remain in place and open to observation until all spray-applied fireproofing is completed and accepted, at which time it may become part of the work.

## SD-06 Test Reports

## Fire Resistance Rating

Reports and test records, attesting that the fireproofing material conforms to the specified requirements. Each test report shall conform to the report requirements specified by the test method.

## Field Tests

Test reports documenting results of tests on the applied material in the project. Report shall include defects identified, repair procedures, and results of the retests when required.

## SD-07 Certificates

### Installer Qualifications

Manufacturer's certification that each listed installer is qualified and trained to install the specified fireproofing. Evidence that each fireproofing installer has had a minimum of 3 years experience in installing the specified type of fireproofing.

### Surface Preparation

Manufacturer's certification that surfaces to be protected have been inspected and are acceptable to receive spray-applied fireproofing. The statement shall list the structural members and the areas that have been inspected and certified.

### Manufacturer's Inspection

Manufacturer's certification that the spray-applied fireproofing in the entire project complies with the manufacturer's criteria and recommendations.

## 1.3 DELIVERY AND STORAGE

Packaged material shall be delivered in the original unopened containers, marked to show the brand name, the manufacturer, and the UL markings. Fireproofing material shall be kept dry until ready to be used, and shall be stored off the ground, under cover and away from damp surfaces. Damaged or opened containers will be rejected. Material with shelf-life shall be applied prior to expiration of the shelf-life.

## 1.4 ENVIRONMENTAL CONDITIONS

### 1.4.1 Temperature

Substrate and ambient air temperatures shall be maintained above 40 degrees F during application and for 24 hours before and after application. Relative humidity shall be maintained within the limits recommended by the fireproofing manufacturer.

### 1.4.2 Ventilation

Adequate ventilation shall be provided to properly dry the fireproofing after application. In enclosed areas, a minimum of 4 air exchanges per hour shall be provided by forced air circulation.

## 1.5 INSTALLER QUALIFICATIONS

Each installer of fireproofing material shall be trained and have a minimum of 3 years experience in the installation of fireproofing of the type specified.

## 1.6 MANUFACTURER'S SERVICES

The manufacturer or its representative shall be onsite prior to, periodically during, and at completion of the application, to provide the specified inspections and certifications; and to ensure that preparations are adequate and that the material is applied according to manufacturer's recommendations and the contract requirements.

## 1.7 FIRE RESISTANCE RATING

Fire resistance ratings shall be in accordance with the fire rated assemblies listed in UL Fire Resist Dir. Proposed materials not listed in UL Fire Resist Dir shall have fire resistance ratings at least equal to the UL Fire Resist Dir ratings as determined by an approved independent testing laboratory, based on tests specified in UL 263 or ASTM E 119. Fireproofing shall be applied to structural steel members, with the following hourly fire resistance rating and in accordance with the following UL design or approved equivalent.

<u>Element</u>	<u>Fire Rating Schedule</u>	
	<u>Hourly Rating</u>	<u>UL Design Reference</u>
Columns supporting one floor	1	X771
Columns supporting more than one floor	1	X771
Columns supporting roof	1	X771
Floor decks	-	-
Floor supports	1	D918
Roof decks	1	P819
Roof supports	1	P819

## 1.8 EXTENT OF FIREPROOFING

All structural steel, and undersides of steel roof decks shall be protected with spray-applied fireproofing to a fire resistance hour-rating as indicated in the preceding paragraph, unless otherwise indicated.

## PART 2 PRODUCTS

### 2.1 SPRAY-APPLIED FIREPROOFING

Spray-applied fireproofing material, including sealer, shall conform to ASTM E 1042, Class (a), Category A, either Type I or Type II, except that the dust removed shall not exceed 0.0025 gram per square foot of fireproofing material applied as specified in the project. Material shall be asbestos free, and shall resist fungus for a period of 28 days when tested in accordance with ASTM G 21.

#### 2.1.1 Dry Density and Cohesion/Adhesion

Fireproofing shall have a minimum ASTM E 605 dry density and ASTM E 736 cohesion/adhesion properties as follows:

##### 2.1.1.1 Concealed Structural Components

Fireproofing for structural components concealed above the ceiling, or within a wall, chase, or furred space, shall have a minimum average applied dry density of 15 pounds per cubic foot and a cohesion/adhesion strength of

200 psf.

#### 2.1.1.2 Exposed Structural Components

Fireproofing for exposed structural components, except where otherwise specified or indicated, shall have a minimum applied dry density of 22 pounds per cubic foot and a cohesion/adhesion strength of 300 psf.

#### 2.1.1.3 Mechanical Rooms and Storage Areas

Fireproofing for structural components located in mechanical rooms and storage areas shall have a minimum applied dry density of 40 pounds per cubic foot and a cohesion/adhesion strength of 400 psf.

#### 2.1.2 Deflection

Spray-applied fireproofing shall not crack, spall, or delaminate when tested in accordance with ASTM E 759.

#### 2.1.3 Bond-Impact

Spray-applied fireproofing material shall not crack, spall or delaminate when tested in accordance with ASTM E 760.

#### 2.1.4 Compressive Strength

The minimum compressive strength shall be 1000 psf when tested in accordance with ASTM E 761.

#### 2.1.5 Corrosion

Spray-applied fireproofing material shall not contribute to corrosion of test panels when tested as specified in ASTM E 937.

#### 2.1.6 Air Erosion

Dust removal shall not exceed 0.025 gram per square foot when tested in accordance with ASTM E 859.

#### 2.2 SEALER

Sealer shall be the type approved by the manufacturer of the fireproofing material and shall be white color.

#### 2.3 WATER

Water used for material mixing and surface preparation shall be potable.

#### 2.4 INTUMESCENT FIRE RESISTIVE COATING

Provide intumescent fire resistive coating where indicated. Intumescent coating shall be a thin-film coating which intumesces (in a fire, softens and expands to form a meringue-like layer up to 4 inches thick, which insulates the structure and protects the steel from fire). The system shall include a second component decorative layer (topcoat) which acts as a protective layer and finish. Basecoat is not required. Thickness range shall be 0.016 inch to 0.130 inch as required for one hour rating. Color of topcoat shall be as indicated. The coating shall meet or exceed the following characteristics:

- a. Hardness: Shore D81.8.
- b. Abrasion Resistance: Only 0.33 g lost after 2000 cycles (ASTM D 4060).
- c. Impact Resistance: 286 in-lb for 120 mils dry (ASTM D 2794).
- d. Deflection: No cracking, delamination or spalling when subjected to a deflection equal to span / 120 (ASTM E 159).
- e. Bond Strength: 10,886 lbf/sq. ft. for 120 mils dry (ASTM E 736).
- f. Compressive Strength: 157,680 lbf/sq. ft. at 10 percent deformation for 120 mils dry (ASTM E 761).

Coating shall be certified by UL for rating up to one hour when tested in accordance with ASTM E 119. The Firefilm II and Colorcoat system as manufactured by A/D Fire Protection Systems complies with this specification.

### PART 3 EXECUTION

#### 3.1 SURFACE PREPARATION

Surfaces to be fireproofed shall be thoroughly cleaned of dirt, grease, oil, paint, primers, loose rust, rolling lubricant, mill scale or other contaminants that will interfere with the proper bonding of the sprayed fireproofing to the substrate. Painted/primed steel substrates shall be tested in accordance with ASTM E 119, with specified sprayed fireproofing material, to provide the required fire-resistance rating; painted or primed steel surfaces may require a fireproofing bond test to determine if the paint formulation will impair proper adhesion. Overhead areas to be fireproofed shall be cleared of all obstructions interfering with the uniform application of the spray-applied fireproofing. Hardware such as support sleeves, inserts, clips, hanger attachment devices and the like shall be installed prior to the application of the fireproofing. Condition of the surfaces shall be acceptable to the manufacturer prior to application of spray-applied fireproofing. Applications listed for use on primed surfaces shall be coordinated with the manufacturer and shall be in accordance with the manufacturer's recommendations and standards, and detailed in submittal item SD-03 Product Data.

#### 3.2 PROTECTION

Surfaces not to receive spray-applied fireproofing shall be covered to prevent contamination by splatter, rebound and overspray. Exterior openings in areas to receive spray-applied fireproofing shall be covered prior to and during application of fireproofing with tarpaulins or other approved material. Surfaces not to receive fireproofing shall be cleaned of fireproofing and sealer.

#### 3.3 MIXING

Fireproofing material shall be mixed in accordance with the manufacturer's recommendations.

#### 3.4 APPLICATION

### 3.4.1 Sequence

Prior to application of fireproofing on each floor, the manufacturer shall inspect and approve application equipment, water supply and pressure, and the application procedures. Fireproofing shall be applied to underside of steel roof deck and steel floor assemblies only after respective roof or floor construction is complete. No roof or floor traffic shall be allowed during application and during a 7-day minimum curing period. Fireproofing material shall be applied prior to the installation of ductwork, piping and conduits which would interfere with uniform application of the fireproofing.

### 3.4.2 Application Technique

Water pressure and volume shall be maintained to manufacturer's recommendations throughout the fireproofing application. Fireproofing material shall be applied to the thickness and density established for the specified fire resistance rating, in accordance with the procedure recommended by the manufacturer, and to a uniform density and texture. Fireproofing material shall not be tamped to achieve the desired density.

### 3.4.3 Sealer Application

Sealer shall be applied to all fireproofing. Sealer shall be applied after field testing has been conducted and after corrective measures and repairs, if required, have been completed.

## 3.5 FIELD TESTS

The applied fireproofing shall be tested by an approved independent testing laboratory, in approved locations, for density, cohesion/adhesion in accordance with ASTM E 736, and for thickness in accordance with ASTM E 605. Two sets of tests shall be conducted on each floor or 10,000-square-foot area, whichever is less, at the approved locations. Any area showing less than minimum requirements shall be corrected. Proposed corrective measures, in writing, shall be approved before starting the corrective action. Corrected work shall be retested.

### 3.5.1 Thickness, Density, Cohesion/Adhesion

Each structural component type shall be tested at floor and roof decks, beams, columns, joists, and trusses. Minimum average thickness shall be as indicated or required by UL Fire Resist Dir. Density and cohesion/adhesion shall be as specified.

### 3.5.2 Repair

Additional fireproofing material may be added to provide proper thickness. Rejected areas of fireproofing shall be corrected to meet specified requirements by adding fireproofing material to provide the proper thickness, or by removing defects and respraying with new fireproofing material. Repairs shall use same type of fireproofing material as originally applied or patching materials recommended by the manufacturer. Repaired areas shall be retested and reinspected. Fireproofing material shall be applied to voids or damaged areas by hand-trowel, or by respraying.

### 3.5.3 Manufacturer's Inspection

The manufacturer shall inspect the fireproofing work after the work is completed on each floor or area, including testing, repair and clean-up,

and shall certify that the work complies with the manufacturer's criteria and recommendations. Before the sprayed material is covered, and after all of the fireproofing work is completed, including repair, testing, and clean-up; and after mechanical, electrical and other work in contact with fireproofing material has been completed, the manufacturer shall re-inspect the work and certify that the entire project complies with the manufacturer's criteria and recommendations.

-- End of Section --

## SECTION 07840A

FIRESTOPPING  
08/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 119	(1998) Fire Tests of Building Construction and Materials
ASTM E 814	(1997) Fire Tests of Through-Penetration Fire Stops
ASTM E 1399	(1997) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems

## UNDERWRITERS LABORATORIES (UL)

UL 723	(1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials
UL 1479	(1994; Rev thru Feb 1998) Fire Tests of Through-Penetration Firestops
UL 2079	(1998) Tests for Fire Resistance of Building Joint Systems
UL Fire Resist Dir	(1999) Fire Resistance Directory (2 Vol.)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials.

Detail drawings including manufacturer's descriptive data,

typical details conforming to UL Fire Resist Dir or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations or construction joints are to receive firestopping, drawings shall indicate location and type of application.

#### SD-07 Certificates

##### Firestopping Materials.

Certificates attesting that firestopping material complies with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate nationally recognized independent laboratory may be substituted.

##### Installer Qualifications.

Documentation of training and experience.

##### Inspection.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

### 1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above.

### 1.4 STORAGE AND DELIVERY

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

### 1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

#### 1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

### PART 2 PRODUCTS

#### 2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free products complying with the following minimum requirements:

##### 2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resist Dir or by a nationally recognized testing laboratory.

##### 2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application.

##### 2.1.3 Fire Resistance Rating

Firestopping will not be required to have a greater fire resistance rating than that of the assembly in which it is being placed.

##### 2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479. Fire resistance ratings shall be as indicated, but not less than the rating of wall, partition, or floor being penetrated.

##### 2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps such as those between floor slabs or roof decks and curtain walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping

materials and systems that have been tested per ASTM E 119 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E 1399 or UL 2079. Provide firestopping at head of wall as indicated on the drawings.

### PART 3 EXECUTION

#### 3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device.

#### 3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

- a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
- b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
- c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.
- d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.
- e. Construction joints in floors and fire rated walls and partitions.
- f. Other locations where required to maintain fire resistance rating of the construction.

##### 3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

##### 3.2.2 Fire Dampers

Fire dampers shall be installed and firestopped in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

#### 3.3 INSPECTION

Firestopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements.

-- End of Section --

## SECTION 07900A

JOINT SEALING  
06/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 217	(1997) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Backing

Bond-Breaker

Sealant

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

## SD-04 Samples

Exterior sealant color

Submit sample exterior sealant colors.

SD-07 Certificates

Sealant

Certificates of compliance stating that the materials conform to the specified requirements.

### 1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 40 to 90 degrees F when the sealants are applied.

### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 40 and 90 degrees F unless otherwise specified by the manufacturer.

## PART 2 PRODUCTS

### 2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell and 40 to 50 percent oversize for open cell material, unless otherwise indicated.

#### 2.1.1 Rubber

Cellular rubber sponge backing shall be ASTM D 1056, Type 1, open cell, or Type 2, closed cell, Class A, Grade A, round cross section.

#### 2.1.2 Synthetic Rubber

Synthetic rubber backing shall be ASTM C 509, Option I, Type I preformed rods or tubes.

#### 2.1.3 Neoprene

Neoprene backing shall be ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2.

### 2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

### 2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

## 2.4 SEALANT

### 2.4.1 ELASTOMERIC

Elastomeric sealants shall conform to ASTM C 920 and the following:

- a. Two part Polyurethane sealant: Grade NS, Class 25, Use NT (except provide use T for surfaces subject to foot traffic). Provide polyurethane sealant for all applications except tile applications.
- b. Silicone sealant: Type S, Grade NS, Class 25, Use NT (except provide use T for surfaces subject to foot traffic). Provide silicone sealant for tile surfaces.

### 2.4.2 ACOUSTICAL

Rubber or polymer-based acoustical sealant shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant shall have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and shall remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and shall be non-staining.

## 2.5 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

## PART 3 EXECUTION

### 3.1 GENERAL

#### 3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant. Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

#### 3.1.2 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

#### 3.1.3 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

#### 3.1.4 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

### 3.1.5 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

## 3.2 APPLICATION

### 3.2.1 Masking Tape

Masking tape shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

### 3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

### 3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

### 3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

### 3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

## 3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

-- End of Section --

## SECTION 08110

## STEEL DOORS AND FRAMES

## 05/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI A250.6 (1997) Hardware on Standard Steel Doors  
(Reinforcement - Application)
- ANSI A250.8 (1998) SDI-100 Recommended Specifications  
for Standard Steel Doors and Frames

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated  
(Galvanized) or Zinc-Iron Alloy-Coated  
(Galvannealed) by the Hot-Dip Process
- ASTM A 924/A 924M (1999) General Requirements for Steel  
Sheet, Metallic-Coated by the Hot-Dip  
Process
- ASTM D 2863 (1997) Measuring the Minimum Oxygen  
Concentration to Support Candle-Like  
Combustion of Plastics (Oxygen Index)
- ASTM E 283 (1991) Rate of Air Leakage Through Exterior  
Windows, Curtain Walls, and Doors Under  
Specified Pressure Differences Across the  
Specimen

## DOOR AND HARDWARE INSTITUTE (DHI)

- DHI A115 (1991) Steel Door Preparation Standards  
(Consisting of A115.1 through A115.6 and  
A115.12 through A115.18)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 80 (1999) Fire Doors and Fire Windows
- NFPA 252 (1999) Standard Methods of Fire Tests of  
Door Assemblies

## STEEL DOOR INSTITUTE (SDOI)

SDI 105

(1998) Recommended Erection Instructions  
for Steel Frames

UNDERWRITERS LABORATORIES (UL)

UL 10B

(1997) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

### SD-02 Shop Drawings

Doors

Frames

Accessories

Weatherstripping

Drawings using standard door type nomenclature in accordance with SDOI SDI 106 indicating the location of each door and frame, elevation of each model of door and frame, details of construction, method of assembling sections, location and extent of hardware reinforcement, hardware locations, type and location of anchors for frames, and thicknesses of metal. Drawings shall include catalog cuts or descriptive data for the doors, frames, method of glazing, and manufacturers printed instructions.

Schedule of doors

Schedule of frames

Submit door and frame locations.

### SD-03 Product Data

Doors

Frames

Accessories

Weatherstripping

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction, panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to ANSI A250.8 requirements.

Fire rated doors

A letter by a nationally recognized testing laboratory which identifies the product manufacturer, type, and model; certifying that the laboratory has tested a sample assembly in accordance with UL 10B and issued a current listing for same.

#### SD-04 Samples

Doors

Frames

Factory-applied prime paint coating

Where colors are not indicated, submit manufacturer's standard colors and patterns for selection.

### 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new. Abraded, scarred, or rusty areas shall be cleaned and touched up with matching finishes.

### 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 5 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 STEEL DOORS AND FRAMES

Doors and frames shall be factory fabricated in accordance with ANSI A250.8 and the additional requirements specified herein. Door Level shall be extra heavy duty (Level 3) except level 4 for exterior doors and frames unless otherwise indicated on the door and door frame schedules. Exterior doors and frames shall be designation A60 galvanized. Interior door frames shall be designation A60 galvanized. Doors and frames shall be prepared to receive hardware conforming to the templates and information provided under Section 08700 BUILDERS' HARDWARE. Doors and frames shall be reinforced, drilled, and tapped to receive mortised hinges, locks, latches, and flush bolts as required. Hinges shall be steel plate 3/16 inch thick by 1-1/2 inches wide by 6 inches longer than hinges, secured by not less than 6 spot welds and two billet welds. Strike plate cap shall be steel plate 3/16 inch thick by 1-1/2 inches wide by 3 inches long. Surface applied closer shall be 12 gauge steel sheet secured with not less than 6 spot welds. Doors and frames shall be reinforced for surface applied hardware. Frames shall be welded type for metal stud partitions and welded type for masonry walls and partitions. Door frames shall be furnished with a minimum of three jamb anchors (4 at doors greater than 7 foot - 6 inches high) and one floor anchor per jamb. Anchors for masonry walls shall be not less than 7 gauge zinc coated steel or 3/16 inch diameter wire at metal stud partitions. Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding. For wall

conditions that do not allow the use of a floor anchor, an additional jamb anchor shall be provided. Rubber silencers shall be furnished for installation into factory predrilled holes in door frames; holes shall be protected with plaster guards or polystyrene glued to frame, adhesively applied silencers are not acceptable. Where frames are installed in masonry walls, plaster guards shall be provided. Provide 26 gauge plaster guards or dust cover boxes, welded to frame at back of all finish hardware cutouts where mortar or other materials might obstruct hardware installation. Reinforcing of door assemblies for closers and other required hardware shall be in accordance with ANSI A250.8 and the conditions of the fire door assembly listing when applicable. Exterior doors shall have top edges closed flush and sealed against water penetration. Doors shall be provided with spreader bars across bottom of frames, tack welded to jambs or mullions.

#### 2.1.1 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

#### 2.2 FIRE RATED DOORS

Fire rated door assemblies shall bear the listing identification label of a nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with UL 10B and NFPA 252 and having a listing for the tested assemblies. The fire resistance rating shall be as shown. Doors exceeding the sizes for which listing label service is offered shall be in accordance with UL 10B. Listing identification labels shall be constructed and permanently applied by a method which results in their destruction should they be removed.

#### 2.3 THERMAL INSULATED DOORS

The thermal insulated doors shall have a minimum insulated value of R10. The interior of thermal insulated doors shall be filled with rigid plastic foam permanently bonded to each face panel. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863.

#### 2.4 WEATHERSTRIPPING

Unless otherwise specified in Section 08700 BUILDERS' HARDWARE, weatherstripping shall be as follows: Weatherstripping for head and jamb shall be manufacturer's standard elastomeric type of synthetic rubber, vinyl, or neoprene and shall be installed at the factory or on the jobsite in accordance with the door frame manufacturer's recommendations. Weatherstripping for bottom of doors shall be as shown. Air leakage rate of weatherstripping shall not exceed 0.20 cfm per linear foot of crack when tested in accordance with ASTM E 283 at standard test conditions.

#### 2.5 SIDELIGHT PANELS

Panels for sidelight shall be constructed in accordance with ANSI A250.8. Panels shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors.

#### 2.6 ACCESSORIES

### 2.6.1 Astragals

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08710, "Door Hardware," provide overlapping steel astragals with the doors.

### 2.6.2 Moldings

Provide moldings around glass of interior doors. Moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Moldings shall be removable to secure side of frame.

## 2.7 STANDARD STEEL FRAMES

### 2.7.1 Stops and Beads

Form stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inches on centers. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

### 2.7.2 Cased Openings

Fabricate frames for cased openings of same material, gage, and assembly as specified for metal door frames, except omit door stops and preparation for hardware.

## 2.8 FIRE DOORS AND FRAMES

NFPA 80 and this specification. The requirements of NFPA 80 shall take precedence over details indicated or specified.

### 2.8.1 Labels

Fire doors and frames shall bear the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing shall be in accordance with NFPA 252 or UL 10B. Labels shall be metal with raised letters, and shall bear the name or file number of the door and frame manufacturer. Labels shall be permanently affixed at the factory to frames and to the hinge edge of the door. Door labels shall not be painted.

### 2.8.2 Oversized Doors

For fire doors and frames which exceed the size for which testing and labeling are available, furnish certificates stating that the doors and frames are identical in design, materials, and construction to a door which has been tested and meets the requirements for the class indicated.

### 2.8.3 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

## 2.9 WEATHERSTRIPPING

As specified in Section 08710, "Door Hardware."

## 2.10 HARDWARE PREPARATION

Provide as specified and where not specified provide minimum hardware reinforcing gages as specified in ANSI A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of ANSI A250.8 and ANSI A250.6.

For additional requirements refer to DHI A115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of ANSI A250.8, as applicable. Punch door frames, with the exception of frames that will have weatherstripping or soundproof gasketing, to receive a minimum of three rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

## 2.11 FINISHES

### 2.11.1 Hot-Dip Zinc-Coated (Galvannealed) and Factory-Primed Finish

Fabricate exterior and interior doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A 924/A 924M and ASTM A 653/A 653M. The Coating weight shall meet or exceed the minimum requirements for coatings having 0.6 ounces per square foot, total both sides, i.e., A60. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in ANSI A250.8. Provide for exterior and interior doors and frames.

## 2.12 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. On wraparound frames for masonry partitions, provide a throat opening 1/8 inch larger than the actual masonry thickness. Design other frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive sealant.

### 2.12.1 Grouted Frames

For frames to be installed in masonry walls, fill with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Frames

Set frames in accordance with SDI 105. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion

bolts. Build in or secure wall anchors to adjoining construction. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing. Backfill frames with mortar. When an additive is provided in the mortar, coat inside of frames with corrosion-inhibiting bituminous material. For frames in exterior walls, ensure that stops are filled with rigid insulation before grout is placed. Contractor shall coordinate the work with that of other trades and shall verify opening dimensions with contract and shop drawings.

### 3.1.2 Doors

Hang doors in accordance with clearances specified in ANSI A250.8. After erection and glazing, clean and adjust hardware.

### 3.1.3 Fire Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80.

## 3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of one coat cold galvanize paint and one coat of rust-inhibitive paint of the same type used for shop coat.

## 3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

## SECTION 08120

## ALUMINUM DOORS, FRAMES, AND WINDOWS

**09/99**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA 1 (1997) Aluminum Standards and Data

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/NWWDA 101/I.S.2 (1997) Voluntary Specification for Aluminum, Vinyl (PVC), and Wood Windows and Glass Doors

AAMA CW-10 (1997) Care and Handling of Architectural Aluminum from Shop to Site

AAMA 1302 (1976) Forced-Entry Resistant Aluminum Prime Windows

AAMA 1503.1 (1988) Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AAMA 2605 (1998) Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1997; Rev. A) Carbon Structural Steel

ASTM A 572/A 572M (1998) High-Strength Low-Alloy Columbium-Vanadium of Structural Steel

ASTM B 26/B 26M (1997) Aluminum-Alloy Sand Castings

ASTM B 108 (1997) Aluminum-Alloy Permanent Mold Castings

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221 (1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM C 542 (1994) Lock-Strip Gaskets

ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 864	(1998) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 1048	(1997; Rev. B) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM E 34	(1994; R 1998) Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E 283	(1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 331	(1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

#### AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel
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## 1.2 SYSTEM DESCRIPTION

Frames and swing-type aluminum doors, of size and design shown on the drawings, shall be provided at the locations indicated. Frames shall be furnished complete with doors, transoms, adjoining sidelights, windows, trim, and other accessories indicated and specified. Frames include both window frames and door frames.

## 1.3 PERFORMANCE REQUIREMENTS

### 1.3.1 Structural

Shapes and thicknesses of framing members shall be sufficient to withstand a design wind load of not less than 40 pounds per square foot of supported area with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65. Provide glazing beads, moldings, and trim of not less than 0.050 inch nominal thickness.

### 1.3.2 Air Infiltration

When tested in accordance with ASTM E 283, air infiltration shall not exceed 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 6.24 pounds per square foot (50 mile per hour wind).

### 1.3.3 Water Penetration

In addition to weather performance, frame assemblies shall meet the following force protection criteria: Frames, mullions, and window hardware shall be designed to resist a static load of 7 kilopascals (1 lb. per square inch) applied to the surface of the glazing. Frame and mullion deformations shall not exceed L/160 of the unsupported member lengths. The glazing shall have a minimum frame bite of 9.5 mm (3/8 inches) for structural glazed window systems and 25 mm (1 inch) for window systems that

are not structural glazed. Frame connections to surrounding walls shall be designed to resist a combined loading consisting of a tension force of 35 kN/m (200 lbs./in.) and a shear force of 13 kN/m (75 lbs./in.).

Windows shall comply with AAMA/NWDA 101/I.S.2; windows designated for resistance to forced entry shall also conform to the requirements of AAMA 1302. In addition to compliance with AAMA/NWDA 101/I.S.2, window framing members for each individual lite of glass shall not deflect to the extent that deflection perpendicular to the glass lite exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Structural calculations for deflection requirements. Provide windows of types, performance classes, performance grades, and sizes indicated. Design windows to accommodate glass, and accessories to be furnished. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factory (CRF) of 61 when tested in accordance with AAMA 1503.1.

When tested in accordance with ASTM E 331, there shall be no water penetration at a pressure of 8 pounds per square foot of fixed area.

#### 1.4 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

##### SD-02 Shop Drawings

Doors and frames; G, AE

Show elevations of each door type transom, size of doors, transoms, sidelights, windows, and frames, metal gages, details of doors, transom, sidelight, windows and frame construction, methods of anchorage, glazing details, weatherstripping, provisions for and location of hardware, and details of installation.

##### SD-04 Samples

Finishes; G

Samples of the painted finish.

##### SD-05 Design Data

Calculations; G, AE

##### SD-06 Test Reports

Aluminum doors, windows, transoms, and sidelights

For full-glazed and flush doors, windows, transoms, and sidelights, certified test reports from an independent testing laboratory, stating that doors, windows, transoms, and sidelights are identical in design, materials, and construction to a door that has been tested and meets all test and specified requirements.

##### SD-08 Manufacturer's Instructions

Doors and frames

Submit detail specifications and instructions for door and window systems installation, adjustments, cleaning, and maintenance.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage. Unload and store with minimum handling in accordance with recommendations contained in AAMA CW-10.

Provide storage space in dry location with adequate ventilation, free from dust or water, and easily accessible for inspection and handling. Stack materials on nonabsorptive strips or wood platforms. Do not cover doors, windows, and frames with tarps, polyethylene film, or similar coverings. Protect finished surfaces during shipping and handling using manufacturer's standard method, except that no coatings or lacquers shall be applied to surfaces to which sealant, calking, and glazing compounds must adhere. Prior to delivery, mark components to correspond with shop and erection drawings placement location and erection.

#### 1.6 QUALITY ASSURANCE

##### 1.6.1 Testing Requirements

The components listed below shall have been tested in accordance with the requirements below, and shall meet performance requirements specified.

- a. Joint and Glazing Sealants: Perform tests as required by applicable publications referenced.
- b. Preformed Compression Gaskets and Seals: ASTM C 864.
- c. Preformed Lock-strip Gaskets: ASTM C 542, modified as follows: Heat age specimens seven days at 158 degrees F, in zipped or locked position under full design compression. Unzip, cool for one hour, re-zip, and test lip seal pressure, which shall be minimum 2.5 pounds per linear inch on any extruded or corner specimen.
- d. Spandrel Glass: Fallout resistance test, ASTM C 1048.

##### 1.6.2 Window Tests

Windows shall meet the requirements specified in Section 0810A, GLASS AND GLAZING except where the requirements of this section differ, this section shall govern. Windows shall meet the same requirements for deflection and structural adequacy as specified for framing members when tested in accordance with ASTM E 330 except permanent deformation shall not exceed 0.4 percent; there shall be no glass breakage, and no permanent damage to fasteners, anchors, hardware, or operating devices. Windows shall have no water penetration when tested in accordance with ASTM E 331.

##### 1.6.3 Fire Resistance Tests

Insulation field applied in conjunction with the window system shall have a flame spread rating not exceeding 75 and a smoke developed rating not exceeding 150 when tested in accordance with ASTM E 84, except as specified otherwise herein.

- a. Window Systems: Material for firestopping the opening between the edge of the floor slab and back of the curtain wall system, shall have not less than the flame spread and smoke developed ratings specified for insulation which is neither isolated from the

building interior nor encased in masonry cores.

- b. Firestopping Materials and Devices: Firestopping material and attachment devices shall be an effective barrier against the spread of fire, smoke, and gases for a period of 2 hours when exposed to the conditions of the standard ASTM E 119 time-temperature curve for a period equivalent to the fire rating of the floor system and shall also be rated noncombustible when tested in accordance with ASTM E 136.

#### 1.6.4 SOURCE QUALITY CONTROL

##### 1.6.4.1 Window Assembly Structural Test

###### 1.6.4.1.# Test Sample Number

At least two sample window assemblies for each type of window provided shall be tested, under an increasing uniform static load. Number of samples, beyond two, is left up to the vendor. However, it is noted that the acceptance criteria encourages a larger number of test samples.

###### 1.6.4.1.# Test Procedure

Test windows (glass panes and support frame) shall be identical in type, size, sealant, gasket or bead and construction to those furnished by the window manufacturer. The frame assembly in the test setup shall be secured by boundary conditions that simulate the adjoining walls of the structure for intended installation. The simulation securing boundary conditions shall be verified and attested by an attending Professional Engineer. Using either a vacuum or a liquid-filled bladder, an increasing uniform load shall be applied to the entire window assembly (glass and frame) until failure occurs in either the glass or frame. Failure shall be defined as either breaking of glass or loss of frame resistance. The failure load,  $r_f$ , shall be recorded to three significant figures. The load should be applied at a rate of 0.5 ru per minute where ru is the static design resistance:

<u>Glass Size</u>	<u>Static Design Resistance</u>
36 x 36 inch	1.2 psi

###### 1.6.4.1.# Acceptance Criteria

The static load capacity ( $r_s$ ) of a glass pane for the specified acceptance test procedure is:

$$r_s = 0.876 r_u \quad (1)$$

The window assembly (frame and glass) is considered acceptable when the arithmetic mean of all the samples tested,  $r$ - such that:

$$r- \Rightarrow r_s + sA$$

where:  $r_s$  = static load capacity of the glass pane for certification testing

$s$  = sample standard deviation

$A$  = acceptance coefficient (Table 1)

- a. Arithmetic mean/standard deviation: For n test samples,  $r$ - is

defined as:

$$r- = \text{sum from } i = 1 \text{ thru } n \text{ for } r_{fi} \text{ divided by } n \quad (3)$$

where  $r_{fi}$  is the recorded failure load of the  $i$ th test sample.

The sample standard deviation,  $s$ , is defined as:

$$s = \text{the square root of the quantity of the sum from } i = 1 \text{ thru } n \text{ for } (r_{fi} - r-)^2 \text{ divided by } (n - 1) \quad (4)$$

The minimum value of the sample standard deviation,  $s$ , permitted to be employed in Equation (2) is:

$$s = 0.145 r_s \quad (5)$$

This assures a sample standard deviation no better than observed for the general population of tempered glass.

- b. Additional sampled determination: The following equation can be used by tester to determine if additional test samples are justified. If:

$$r- \leq r_s + s_B \quad (6)$$

then with 90 confidence, the design will not prove to be adequate with additional tests. Obtain rejection coefficient,  $B$ , from Table 1.

Table 1. Statistical Acceptance and Rejection Coefficients

Number of Window Assemblies <u>n</u>	Acceptance Coefficient <u>A</u>	Rejection Coefficient <u>B</u>
2	4.14	.546
3	3.05	.871
4	2.78	1.14
5	2.65	1.27
6	2.56	1.36
7	2.50	1.42
8	2.46	1.48
9	2.42	1.49
10	2.39	1.52
11	2.37	1.54
12	2.35	1.57
13	2.33	1.58
14	2.32	1.60
15	2.31	1.61
16	2.30	1.62
17	2.28	1.64
18	2.27	1.65
19	2.27	1.65
20	2.26	1.66
21	2.25	1.67
22	2.24	1.68
23	2.24	1.68
24	2.23	1.69
25	2.22	1.70

Table 1. Statistical Acceptance and Rejection Coefficients

Number of Window Assemblies <u>n</u>	Acceptance Coefficient <u>A</u>	Rejection Coefficient <u>B</u>
30	2.19	1.72
40	2.17	1.75
50	2.14	1.77

#### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a five-year period shall be provided.

#### 1.8 REQUIREMENT FOR DESIGN DATA

Submit structural and thermal calculations for complete window and door assemblies.

#### 1.9 DOOR AND WINDOW SYSTEM REQUIREMENTS

Provide system complete with framing, doors, mullions, trim, windows, glass, glazing, sealants, insulation, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing the wall to the structure as specified or indicated. Glass and Glazing is specified in Section 08810A.

##### 1.9.1 Source

Window and door system components shall be furnished by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

##### 1.9.2 Design

Stick system with sheer blocks. Fully coordinate system accessories directly incorporated, and adjacent to contiguous related work and insure materials compatibility, deflection limitations, thermal movements, and clearances and tolerances as indicated or specified.

##### 1.9.3 Thermal Movement

Fabricate, assemble, and erect system with adequate allowances for expansion and contraction of components and fastenings to prevent buckling damage, joint seal failure, glass breakage, undue stress on fastenings or other detrimental effects. For design purposes, base provisions for thermal movement on assumed ambient temperature range of from 0 degrees F to 110 degrees F.

##### 1.9.4 Tolerances

Design and erect wall system to accommodate tolerances in building frame and other contiguous work as indicated or specified. Provide with the following tolerances:

- a. Maximum variation from plane or location shown on approved shop drawings: 1/8 inch per 12 feet of length up to not more than 1/2 inch in any total length.

- b. Maximum offset from true alignment between two identical members abutting end to end in line: 1/16 inch.

#### 1.10 QUALIFICATION OF WELDERS

Welding shall be performed by certified welders qualified in accordance with AWS D1.1 using procedures, materials, and equipment of the type required for the work.

### PART 2 PRODUCTS

#### 2.1 DOORS AND FRAMES

Swing-type aluminum doors and frames of size, design, and location indicated. Provide doors complete with frames, framing members, subframes, transoms, adjoining sidelights, adjoining window wall, windows, trim, and accessories.

#### 2.2 MATERIALS

##### 2.2.1 Anchors

Stainless steel or steel with hot-dipped galvanized finish.

##### 2.2.2 Weatherstripping

Continuous wool pile, silicone treated, or type recommended by door manufacturer.

##### 2.2.3 Aluminum Alloy for Doors and Frames

ASTM B 221, Alloy 6063-T5 for extrusions. ASTM B 209, alloy and temper best suited for aluminum sheets and strips. Shall be free from defects impairing strength or durability of surface finish. Standard alloys shall conform to standards and designations of AA 1. Special alloys, not covered by the following ASTM specifications, shall conform to standards and designations recommended by the manufacturer for the purpose intended.

##### 2.2.3.1 Wrought Aluminum Alloys

Shall be those which include aluminum alloying elements not exceeding the following maximum limits when tested and additional in accordance with ASTM E 34. These limits apply to both bare products and the core of clad products. The cladding of clad products shall be within the same limits except that the maximum zinc limit may be 2.5 percent in order to assure that the cladding is anodic to the core. Special wrought alloys with a silicon content not more than 7.0 percent will be acceptable for limited structural uses where special appearance is required:

<u>ALLOY</u>	<u>PERCENT</u>
Silicon	1.5
Magnesium, Manganese, and Chromium combined	6.0
Iron	1.0

<u>ALLOY</u>	<u>PERCENT</u>
Copper	0.4
Zinc	1.0

Within the chemical composition limits set forth above, wrought aluminum alloys shall conform to the following:

- a. Extruded bars, rods, shapes and tubes: ASTM B 221.
- b. Sheet and Plate: ASTM B 209.

#### 2.2.3.2 Cast Aluminum Alloys

Provide those in which the alloying elements are silicon, magnesium, manganese, or a combination of these. Other elements shall not exceed the following limits:

<u>ELEMENT</u>	<u>PERCENT</u>
Iron	1.2
Copper	0.4
Nickel	0.4
Titanium	0.2
Others (total)	0.5

Within the chemical composition limits set forth above, cast aluminum alloys shall conform to the following:

- a. Sand castings: ASTM B 26/B 26M.
- b. Die casting: ASTM B 85.
- c. Permanent mold castings: ASTM B 108.

#### 2.2.3.3 Strength

Aluminum extrusions for framing members used in curtain walls and main frame and sash or ventilator members in windows shall have a minimum ultimate tensile strength of 22,000 psi and a minimum yield strength of 16,000 psi.

#### 2.2.4 Fasteners

Hard aluminum or stainless steel.

#### 2.2.5 Structural Steel

ASTM A 36/A 36M.

#### 2.2.6 High-Strength, Low-Alloy Steel

Conform to ASTM A 572/A 572M for structural shapes, plates, and bars.

### 2.2.7 Aluminum Paint

Type as recommended by aluminum door manufacturer.

### 2.2.8 Joint Sealants and Accessories

Provide manufacturer's standard colors as closely matching the adjacent surfaces as possible.

#### 2.2.8.1 Elastomeric, Single or Multiple Component

ASTM C 920, Type S, single component or Type M, multiple component. Use Grade NS, nonsag type in joints on vertical surfaces and use Grade P, self-leveling or flow type, in joints on horizontal surfaces.

#### 2.2.8.2 Single Component Silicone Rubber Base

ASTM C 920, Type S, Grade NS (Silicone).

#### 2.2.8.3 Solvents and Primers

Provide material which is quick drying, colorless, nonstaining, compatible with compound used, as recommended by sealant manufacturer. Where primer is specified or recommended by sealant manufacturer, tests related to that material shall include primer.

#### 2.2.8.4 Backing Material

Provide material which is nonstaining, nonabsorbent, and compatible with sealing compound. Closed cell resilient urethane, polyvinylchloride or polyethylene foam; closed-cell sponge of vinyl or rubber; closed cell neoprene or butyl rod; or polychloroprene tubes or beads.

#### 2.2.8.5 Bond Preventive Materials

Provide polyethylene tape with pressure-sensitive adhesive; aluminum foil or waxed paper.

#### 2.2.8.6 Preformed Sealing Compound

Provide nonskinning type conforming to AAMA 800. Tapes, beads, ribbons or other shapes as required.

### 2.2.9 Glass and Glazing

Materials are specified under Section 08810N, "Glass and Glazing."

#### 2.2.9.1 Glass Sizes and Clearances

Sizes indicated are nominal. Verify actual sizes required by measuring frames. Coordinate dimensions for glass and glass holding members to meet applicable minimum clearances as recommended by glass manufacturer and to meet force protection criteria. Do not nip to remove flares or to reduce oversized dimensions.

#### 2.2.10 Firestopping Material

Mineral fiber manufactured from asbestos-free materials, and conforming to ASTM C 612 or ASTM C 665, meeting fire resistance requirements specified.

## 2.3 FABRICATION

### 2.3.1 Aluminum Frames for Doors and Windows

Frames shall be double-glazed window wall system and shall have a minimum condensation resistance factor of 54 in accordance with AAMA 1503. Frames shall be fabricated of extruded aluminum shapes to contours as shown on the drawings. Shapes shown are representations of design, function, and required profile. Dimensions shown are minimum. Shapes shown are steel reinforced aluminum curtainwall profiles to meet force protection requirements. Shapes of equivalent design may be submitted, subject to approval of samples. Minimum metal wall thickness shall be as required to meet the structural performance of the system. Frames that are to receive glass shall have removable snap-on glass stops and glazing beads with structural silicone glazing compounds. Joints in frame members shall be milled to a hairline tight fit so that raw edges of the assembly are not visible, welded, or mechanically joined, sealed internally to prevent water infiltration, reinforced, and secured mechanically by appropriate screws or by screw spline attachment. Frames shall have thermal break.

### 2.3.2 Aluminum Doors

Of type, size, and design indicated and not less than 1 3/4 inches thick. Minimum wall thickness, 0.125 inch, except beads and trim, 0.050 inch. Door sizes shown are nominal and shall include standard clearances as follows: 0.093 inch at hinge and lock stiles, 0.125 inch between meeting stiles, 0.125 inch at top rails, 0.187 inch between bottom and threshold, and 0.687 inch between bottom and floor. Bevel single-acting doors 0.125 inch at lock, hinge, and meeting stile edges.

#### 2.3.2.1 Full Glazed Stile and Rail Doors

Doors shall have medium stiles and rails as indicated. Fabricate from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Fasten top and bottom rail together by means of welding or by 3/8 or 1/2 inch diameter cadmium-plated tensioned steel tie rods. Provide an adjustable mechanism of jack screws or other methods in the top rail to allow for minor clearance adjustments after installation.

### 2.3.3 Welding and Fastening

Where possible, locate welds on unexposed surfaces. Dress welds on exposed surfaces smoothly. Select welding rods, filler wire, and flux to produce a uniform texture and color in finished work. Remove flux and spatter from surfaces immediately after welding. Exposed screws or bolts will be permitted only in inconspicuous locations, and shall have countersunk heads. Weld concealed reinforcements for hardware in place.

### 2.3.4 Weatherstripping

Provide on stiles and rails of exterior doors. Fit into slots which are integral with doors or frames. Weatherstripping shall be replaceable without special tools, and adjustable at meeting rails of pairs of doors. Installation shall allow doors to swing freely and close positively. Air leakage of a single leaf weatherstripped door shall not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283.

### 2.3.5 Anchors

On the backs of subframes, provide anchors of the sizes and shapes required to comply with force protection criteria specified for securing subframes to adjacent construction. Anchor transom bars at ends and mullions at head and sill. Reinforce vertical and/or horizontal mullions with structural steel members of sufficient length to extend up to the overhead structural slab or framing and secure thereto. Reinforce and anchor door frames to floor construction as indicated on approved shop drawings and in accordance with manufacturer's recommendation. Place anchors as required to comply with force protection criteria specified but not less than at top and bottom of each jamb and at intermediate points not more than 25 inches apart.

### 2.3.6 Provisions for Hardware

Refer to Section 08710, "Door Hardware" for requirements for hardware items other than those indicated herein to be provided by manufacturer of aluminum entrances. Provide door manufacturer's standard heavy-duty hardware units as indicated, scheduled, or required for operation of each door leaf, including the following items of sizes, number, and type recommended by manufacturer for service required, finished to match door, unless otherwise indicated.

#### 2.3.6.1 Hinges

Provide Grade 1, heavy-duty, continuous roton hinges powder coated to match aluminum finish for each door as required for door size, weight, and force protection criteria.

#### 2.3.6.2 Exit Devices

Type as required, Function 08, BHMA 626.

#### 2.3.6.3 Thresholds

Extruded aluminum in mill finish, complete with anchors and clips. Manufacturer's standard offset pivot threshold 1/2 inch high.

#### 2.3.6.4 Cylinders

Cylinders are specified in Section 08710, "Door Hardware."

#### 2.3.6.5 Closers

C02021 PT1, PT4C, PT4D, PT4H, 689.

#### 2.3.6.6 Holders

Provide Rixson closer 9 Series x TB bronze or equal. BHMA 626. Provide hold open feature at each entrance door.

#### 2.3.6.7 Stops

Provide Trimco stops 1201 ES or equal as applicable.

#### 2.3.6.8 Door Bottom Sweeps

Provide Pemco 345 AV or equal at all exterior doors.

#### 2.3.6.9 Low Energy Power Open Door

Provide low energy power open door operator to Door A100A only per ANSI/BHMA A156.19 for size of door specified. Provide signage for both sides of doors and push button actuator both sides of doors. Power open ability shall be for one leaf of pair only.

#### 2.3.7 Provisions for Glazing

Provide extruded aluminum snap-in glazing beads on interior side of doors. Provide extruded aluminum, theft-proof, snap-in glazing beads or fixed glazing beads on exterior or security side of doors. Glazing beads shall have vinyl insert glazing gaskets or structural silicone glazed to comply with the specified force protection criteria. Design glazing beads to receive glass of thickness indicated or specified. Glazing is specified in Section 08810A, "Glass and Glazing."

#### 2.3.8 Finishes

Provide exposed aluminum surfaces with factory finish of organic coating.

##### 2.3.8.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a superior-performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mils. The finish color shall be as indicated.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Plumb, square, level, and align frames and framing members to receive doors, transoms, adjoining sidelights, windows, and adjoining window walls. Anchor frames to surrounding walls in accordance with manufacturer's approved installation drawings. Frame anchorage shall resist the combined loading of the specified tension force and shear force. Anchor frames to adjacent construction as indicated and in accordance with manufacturer's printed instructions. Anchor bottom of each frame to rough floor construction with 3/32 inch thick stainless steel angle clips secured to back of each jamb and to floor construction; use stainless steel bolts and expansion rivets for fastening clip anchors. Seal metal-to-metal joints between framing members as specified in Section 07900, "Joint Sealing." Hang doors to produce clearances specified in paragraph entitled "Aluminum Frames for Doors and Windows," of this section. After erection and glazing, adjust doors and hardware to operate properly.

#### 3.2 FABRICATION

The components shall be of the materials and thickness indicated or specified. The details indicated are representative of the required design and profiles. Acceptable designs may differ from that shown if the proposed system components conform to the limiting dimensions indicated and the requirements specified herein. Unless specifically indicated or specified otherwise, the methods of fabrication and assembly shall be at the discretion of the door and window manufacturer. Perform fitting and assembling of components in the shop to the maximum extent practicable. Anchorage devices shall permit adjustment in three directions. Exposed fastenings used on finished surfaces shall be truss head, flat head, or

oval head screws or bolts.

### 3.2.1 Joints

Provide welded or mechanical fasteners as indicated or specified. Match joints in exposed work to produce continuity of line and design. Bed-joints or rabbets receiving calking or sealing material shall be minimum 3/4 inch deep and 3/8 inch wide at mid ambient temperature range.

### 3.2.2 Welding

Conform to AWS D1.1. Use methods and electrodes recommended by manufacturers of base metal alloys. Welding rods shall be of an alloy that matches the color of the metal being welded. Protect glass and other finish from exposure to welding spatter. Ground and finish weld beads on exposed metal surfaces to minimize mismatch and to blend with finish on adjacent parent metal. If flux is used in welding aluminum, completely remove it immediately upon completion of welding operations. Do not use exposed welds on aluminum surfaces.

### 3.2.3 Soldering and Brazing

Provide as recommended by suppliers. Solder only for filling or sealing joints.

### 3.2.4 Ventilation and Drainage

Provide internal ventilation drainage system of weeps or based on principles of pressure equalization to ventilate the wall internally and to discharge condensation and water leakage to exterior as inconspicuously as possible. Flashings and other materials used internally shall be nonstaining, noncorrosive, and nonbleeding.

### 3.2.5 Protection and Treatment of Metals

#### 3.2.5.1 General

Remove from metal surfaces lubricants used in fabrication and clean off other extraneous material before leaving the shop.

#### 3.2.5.2 Galvanic Action

Provide protection against galvanic action wherever dissimilar metals are in contact, except in the case of aluminum in permanent contact with galvanized steel, zinc, stainless steel, or relatively small areas of white bronze. Paint contact surfaces with one coat bituminous paint or apply appropriate calking material or nonabsorptive, noncorrosive, and nonstaining tape or gasket between contact surfaces.

#### 3.2.5.3 Protection for Aluminum

Protect aluminum which is placed in contact with, built into, or which will receive drainage from masonry, lime mortar, concrete, or plaster with one coat of alkali-resistant bituminous paint. Where aluminum is contacted by absorptive materials subject to repeated wetting or treated with preservative noncompatible with aluminum, apply two coats of aluminum paint, to such materials and seal joints with approved calking compound.

## 3.3 INSTALLATION

Installation and erection of glazed wall system and all components shall be performed under direct supervision of and in accordance with approved recommendations and instructions of wall system manufacturer or fabricator.

#### 3.3.1 Bench Marks and Reference Points

Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenient points on each floor level. Should any error or discrepancy be discovered in location of the marks, stop erection work in that area until discrepancies have been corrected.

### 3.4 PROTECTION FROM DISSIMILAR MATERIALS

#### 3.4.1 Dissimilar Metals

Where aluminum surfaces come in contact with metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by one or a combination of the following methods:

- a. Paint the dissimilar metal with one coat of heavy-bodied bituminous paint.
- b. Apply a good quality elastomeric sealant between the aluminum and the dissimilar metal.
- c. Paint the dissimilar metal with one coat of primer and one coat of aluminum paint.
- d. Use a nonabsorptive tape or gasket in permanently dry locations.

#### 3.4.2 Drainage from Dissimilar Metals

In locations where drainage from dissimilar metals has direct contact with aluminum, provide protective paint, to prevent aluminum discoloration.

#### 3.4.3 Masonry and Concrete

Provide aluminum surfaces in contact with mortar, concrete, or other masonry materials with one coat of heavy-bodied bituminous paint.

#### 3.4.4 Wood or Other Absorptive Materials

Provide aluminum surfaces in contact with absorptive materials subject to frequent moisture, and aluminum surfaces in contact with treated wood, with two coats of aluminum paint or one coat of heavy-bodied bituminous paint. In lieu of painting the aluminum, the Contractor shall have the option of painting the wood or other absorptive surface with two coats of aluminum paint and sealing the joints with elastomeric sealant.

#### 3.4.5 Verifying Conditions and Adjacent Surfaces

After establishment of lines and grades and prior to system installation examine supporting structural elements. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between curtain wall and structural frames, and other permissible dimensional tolerances in the building frame.

#### 3.4.6 Windows

Install windows in accordance with details indicated and approved detail drawings.

#### 3.4.6.1 Sealing

Seal exterior metal to metal joints between members of windows, frames, mullions, and mullion covers. Remove excess sealant.

#### 3.4.7 Joint Sealants

##### 3.4.7.1 Surface Preparation

Surfaces to be primed and sealed shall be clean, dry to the touch, free from frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter. Enclose joints on three sides. Clean out grooves to proper depth. Joint dimensions shall conform to approved detail drawings with a tolerance of plus 1/8 inch. Do not apply compound unless ambient temperature is between 40 and 90 degrees F. Clean out loose particles and mortar just before sealing. Remove protective coatings or coverings from surfaces in contact with sealants before applying sealants or tapes. Solvents used to remove coatings shall be of type that leave no residue on metals.

##### 3.4.7.2 Applications

Match approved sample. Force compound into grooves with sufficient pressure to fill grooves solidly. Sealing compound shall be uniformly smooth and free of wrinkles and, unless indicated otherwise, shall be tooled and left sufficiently convex to result in a flush joint when dry. Do not trim edges of sealing material after joints are tooled. Mix only amount of multi-component sealant which can be installed within four hours, but at no time shall this amount exceed 5 gallons.

##### 3.4.7.3 Primer

Apply to masonry, concrete, wood, and other surfaces as recommended by sealant manufacturer. Do not apply primer to surfaces which will be exposed after calking is completed.

##### 3.4.7.4 Backing

Tightly pack in bottom of joints which are over 1/2 inch in depth with specified backing material to depth indicated or specified. Roll backing material of hose or rod stock into joints to prevent lengthwise stretching.

##### 3.4.7.5 Bond Prevention

Install bond preventive material at back or bottom of joint cavities in which no backstop material is required, covering full width and length of joint cavities.

##### 3.4.7.6 Protection and Cleaning

Remove compound smears from surfaces of materials adjacent to sealed joints as the work progresses. Use masking tape on each side of joint where texture of adjacent material will be difficult to clean. Remove masking tape immediately after filling joint. Scrape off fresh compound from adjacent surfaces immediately and rub clean with approved solvent. Upon completion of calking and sealing, remove remaining smears, stains, and

other soiling, and leave the work in clean neat condition.

### 3.4.8 Glass

Install in accordance with manufacturer's recommendations.

#### 3.4.8.1 Inspection of Sash and Frames

Before installing glass, inspect frames to receive glass for defects such as dimensional variations, glass clearances, open joints, or other conditions that will prevent satisfactory glass installation. Do not proceed with installation until defects have been corrected.

#### 3.4.8.2 Preparation of Glass and Rabbets

Clean sealing surfaces at perimeter of glass and sealing surfaces of rabbets and stop beads before applying glazing compound, sealing compound, glazing tape, or gaskets. Use only approved solvents and cleaning agents recommended by compound or gasket manufacturer.

#### 3.4.8.3 Positioning Glass

Maintain specified edge clearances and glass bite at perimeter. Maintain position of glass in rabbet and provide required sealant thickness on both sides of glass. For glass dimensions larger than 50 united inches, provide setting blocks at sill and spacer shims on all four sides; locate setting blocks one quarter way in from each jamb edge of glass. Where setting blocks and spacer shims are set into glazing compound or sealant, butter with compound or sealant, place in position, and allow to firmly set prior to installation of glass.

#### 3.4.8.4 Setting Methods

Apply glazing compound, glazing sealant, glazing tape, and gaskets uniformly with accurately formed corners and bevels. Remove excess compound from glass and sash. Use only recommended thinners, cleaners, and solvents. Strip surplus compound from both sides of glass and tool at slight angle to shed water and provide clean sight lines. Secure stop beads in place with suitable fastenings. Do not apply compound or sealant at temperatures lower than 40 degrees F, or on damp, dirty, or dusty surfaces. Setting methods shall be as required to meet industry standards and the specified force protection criteria.

#### 3.4.8.5 Void Space

Heat absorbing, insulating, spandrel, and tempered glass, and glass of other types that exceed 100 united inches in size: Provide void space at head and jamb to allow glass to expand or move without exuding the sealant.

#### 3.4.8.6 Insulating Glass

Provide adequate means to weep incidental water and condensation away from the sealed edges of insulated glass units and out of the wall system. The weeping of lock-strip gaskets should be in accordance with the recommendation of the glass manufacturer.

#### 3.4.8.7 Insulating Glass With Edge Bands

Insulating glass with flared metal edge bands set in lock-strip type

gaskets: Follow glass manufacturer's recommendations and add supplementary wet seal as required; when used with glazing tape, use tapered tape.

#### 3.4.9 Firestopping

Provide firestopping, where indicated, in openings between wall system and floor at each story to prevent passage of flame and hot gases from floor to floor under extended fire exposure. Installed fire stopping shall remain in place under extended fire exposure despite distortions that may occur in wall system components. Securely attach anchoring or containment devices to building structure and not to wall system.

#### 3.5 CLEANING

Upon completion of installation, clean window, door, and frame surfaces in accordance with door manufacturer's recommended procedure. Do not use abrasive, caustic, or acid cleaning agents.

#### 3.6 PROTECTION

Protect windows, doors, and frames from damage and from contamination by other materials such as cement mortar. Prior to completion and acceptance of the work, restore damaged windows, doors, and frames to original condition, or replace with new ones.

-- End of Section --

## SECTION 08210

WOOD DOORS  
09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 90 (1997) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E 152 (1981; Rev. A) Fire Tests of Door Assemblies

## ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI Qual Stds (1997) Architectural Woodwork Quality Standards and Quality Certification Program

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1995) Fire Doors and Fire Windows

NFPA 252 (1995) Fire Tests of Door Assemblies

## WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

NWWDA I.S. 1-A (1993) Architectural Wood Flush Doors

NWWDA TM-5 (1990) Split Resistance Test

NWWDA TM-7 (1990) Cycle - Slam Test

NWWDA TM-8 (1990) Hinge Loading Resistance Test

## UNDERWRITERS LABORATORIES (UL)

UL 10B (1997) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Doors

Submit drawings or catalog data showing each type of door unit; descriptive data of head and jamb weatherstripping with

installation instructions shall be included. Drawings and data shall indicate door type and construction, sizes, thickness, methods of assembly, door louvers, and glazing.

#### SD-03 Product Data

Doors

Accessories

Water-resistant sealer

Sample warranty

Sound transmission class rating; G

Fire resistance rating; G

#### SD-04 Samples

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Door finish colors

Submit a minimum of three color selection samples for selection by the Contracting Officer.

#### SD-06 Test Reports

Split resistance

Cycle-slam

Hinge loading resistance

Submit split resistance test report for doors tested in accordance with NWWDA TM-5, cycle-slam test report for doors tested in accordance with NWWDA TM-7, and hinge loading resistance test report for doors tested in accordance with NWWDA TM-8.

### 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inches thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Do not store in a building under construction until concrete, masonry work, and plaster are dry. Replace defective or damaged doors with new ones.

### 1.4 WARRANTY

Warranty shall warrant doors free of defects as set forth in the door manufacturer's standard door warranty. Warranty shall be for life of

installation.

## PART 2 PRODUCTS

### 2.1 DOORS

Provide doors of the types, sizes, and designs indicated.

#### 2.1.1 Flush Doors

Flush doors shall conform to NWWDA I.S. 1-A, except for the one year acclimatization requirement in paragraph T-2, which shall not apply and comply with AWI as specified. Stile edge bands of doors to receive natural finish shall be hardwood, compatible with face veneer. No visible finger joints will be accepted in stile edge bands. Wood doors shall be 5-ply construction with faces, stiles, and rails bonded to the cores.

##### 2.1.1.1 Interior Flush Doors

Provide particleboard core, Type II flush doors conforming to NWWDA I.S. 1-A with faces of custom grade red oak (plain sliced, book matched).

#### 2.1.2 Acoustical Doors

NWWDA I.S. 1-A, solid core, constructed to provide Sound Transmission Class rating of 45 when tested in accordance with ASTM E 90. Gasketing, thresholds, and drop seals shall be supplied by door supplier. Threshold shall comply with Americans with Disabilities Act (ADA).

#### 2.1.3 Composite-Type Fire Doors

Doors specified or indicated to have a fire resistance rating shall conform to the requirements of UL 10B, ASTM E 152, or NFPA 252 for the class of door indicated. Mineral core shall be provided for fire rated doors. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

## 2.2 ACCESSORIES

### 2.2.1 Door Light Openings

Provide glazed openings with the manufacturer's standard wood moldings except that moldings for doors to receive natural finish shall be of the same specie and color as the face veneers. Moldings for flush doors shall be lip type. Provide glazed openings in fire-rated doors with fire rated frames or approved fire rated veneer wrapped moldings. Glazing is specified in Section 08800N, "Glazing."

### 2.2.2 Additional Hardware Reinforcement

Provide fire rated doors with hardware reinforcement blocking and top, bottom, and intermediate rail blocking. Size of lock blocks shall be as required to secure the hardware specified but not less than 5 inches by 18 inches. Reinforcement blocking shall be in compliance with the manufacturer's labeling requirements and shall not be mineral material similar to the core.

## 2.3 FABRICATION

### 2.3.1 Marking

Each door shall bear a stamp, brand, or other identifying mark indicating quality and construction of the door.

### 2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based and identify doors having a Type I glue bond.

### 2.3.3 Adhesives and Bonds

NWWDA I.S. 1-A. Use Type II bond for interior doors. Adhesive for doors to receive a natural finish shall be nonstaining.

### 2.3.4 Prefitting

Doors shall be provided factory pre-fit. Doors shall be sized and machined at the factory by the door manufacturer in accordance with the standards under which they are produced. The work shall include sizing, bevelling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules as required to coordinate the work. Cutting of doors at project site shall be cause for rejection by Contracting Officer.

### 2.3.5 Finishes

#### 2.3.5.1 Factory Finish

Provide doors finished at the factory by the door manufacturer as follows: AWI Qual Stds Section 1500, specification for System No. 4 Conversion varnish alkyd urea or System No. 5 Vinyl catalyzed. The coating shall be AWI Qual Stds premium, medium rubbed sheen. Use stain when required to produce the finish specified for color. Seal edges, cutouts, trim, and wood accessories, and apply two coats of finish compatible with the door face finish. Touch-up finishes that are lightly scratched or lightly marred shall be repaired, in accordance with the door manufacturer's instructions.

Damaged doors shall be replaced. Match color and sheen of factory finish using materials compatible for field application.

#### 2.3.5.2 Color

Provide door finish colors as indicated.

### 2.3.6 Water-Resistant Sealer

Provide a water-resistant sealer compatible with the specified finishes as approved and as recommended by the door manufacturer.

## 2.4 SOURCE QUALITY CONTROL

Stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges shall meet the following performance criteria:

- a. Split resistance: Average of ten test samples shall be not less than 500 pounds load when tested in accordance with NWWDA TM-5.

- b. Cycle-slam: 200,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of NWWDA TM-7.
- c. Hinge loading resistance: Average of ten test samples shall be not less than 700 pounds load when tested for direct screw withdrawal in accordance with NWWDA TM-8 using a No. 12, 1 1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1 1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job, if approved by Contracting Officer, immediately after cutting using approved water-resistant sealer. Factory fit and trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inches. Door warp shall not exceed 1/4 inch when measured in accordance with NWWDA I.S. 1-A. Bottoms of doors shall be factory undercut to allow clear door swing over finishes.

##### 3.1.1 Fire Doors

Install fire doors in accordance with NFPA 80. Do not paint over labels.

-- End of Section --

## SECTION 08330A

OVERHEAD ROLLING DOORS  
06/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M	(1999a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip process
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 330	(1997e1) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

## AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Hdbk-IP	(1997) Handbook, Fundamentals I-P Edition
ASHRAE Hdbk-SI	(1997) Handbook, Fundamentals SI Edition

## 1.2 DESCRIPTION

Overhead rolling doors shall be spring counterbalanced, rolling type, with interlocking slats, complete with guides, fastenings, hood, brackets, and operating mechanisms, and shall be designed for use on openings as indicated. Each door shall be provided with a permanent label showing the manufacturer's name and address and the model/serial number of the door. Doors in excess of the labelled size shall be deemed oversize and shall be provided with a listing agency oversize label, or a listing agency oversize certificate, or a certificate signed by an official of the manufacturing company certifying that the door and operator have been designed to meet the specified requirements.

## 1.2.1 Wind Load Requirements (Tests)

Doors and components shall be designed to withstand the minimum design wind load of 50 psf. Doors shall be constructed to sustain a superimposed load, both inward and outward, equal to 1-1/2 times the minimum design wind load.

Calculations shall be provided that prove the door design meets the design windload requirements. Test data showing compliance with design windload requirements for the specific door design tested in accordance with the uniform static air pressure difference test procedures of ASTM E 330 shall

be provided. Recovery shall be at least 3/4 of the maximum deflection within 24 hours after the test load is removed. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested

#### 1.2.2 Operational Cycle Life

All portions of the door and door operating mechanism that are subject to movement, wear, or stress fatigue shall be designed to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the full open position, and returns to the closed position.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Overhead Rolling Door Unit; G.

Drawings showing the location of each door including schedules. Drawings shall include elevations of each door type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, details of joints and connections, and details of guides, power operators, controls, and other fittings.

##### SD-03 Product Data

Overhead Rolling Door Unit; G.

Manufacturer's catalog data, test data, and summary of forces and loads on the walls/jambs.

Manufacturer's preprinted installation instructions.

##### SD-06 Test Reports

Tests

Design windload requirements.

##### SD-10 Operation and Maintenance Data

Operation Manual

Maintenance and Repair Manual

Six copies of the system operation manual and system maintenance and repair manual for each type of door and control system.

#### 1.4 DELIVERY AND STORAGE

Doors shall be delivered to the jobsite wrapped in a protective covering

with the brands and names clearly marked thereon. Doors shall be stored in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

#### 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 3-year period shall be provided.

#### 1.6 OPERATION AND MAINTENANCE MANUALS

Operating instructions outlining the step-by-step procedures required for chain door and shutter operation for the overhead rolling door unit shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, troubleshooting guides, and simplified diagrams for the equipment as installed shall be provided. A complete list of parts and supplies, source of supply, and a list of the high mortality maintenance parts shall be provided.

### PART 2 PRODUCTS

#### 2.1 OVERHEAD ROLLING DOORS

Doors shall be surface-mounted type with guides at jambs set back a sufficient distance to clear the opening. Exterior doors shall be mounted as indicated.

##### 2.1.1 Curtains

The curtains shall roll up on a barrel supported at the head of opening on brackets, and shall be balanced by helical torsion springs. Steel slats for doors less than 15 feet wide shall be minimum bare metal thickness of 0.0281 inches. Slats shall be of the minimum bare metal decimal thickness required for the width indicated and the wind pressure specified above.

##### 2.1.1.1 Insulated Curtains

The slat system shall supply a minimum R-value of 4 when calculated in accordance with ASHRAE Hdbk-IP ASHRAE Hdbk-SI. Slats shall be of the flat type as standard with the manufacturer. Slats shall consist of a urethane or polystyrene core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats shall be gauge as specified for curtains. Interior face shall be not lighter than 0.0219 inches. The insulated slat assembly shall have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

##### 2.1.2 Endlocks and Windlocks

The ends of each alternate slat for interior doors shall have steel endlocks of manufacturer's stock design. In addition to endlocks, non-rated exterior doors shall have the manufacturer's standard windlocks as required to withstand the wind load. Windlocks shall prevent the curtain from leaving guides because of deflection from specified wind pressure.

### 2.1.3 Bottom Bar

The curtain shall have a standard bottom bar consisting of two hot-dip galvanized steel angles for steel doors.

### 2.1.4 Guides

Guides shall be steel structural shapes or formed steel shapes, of a size and depth to provide proper clearance for operation and resistance under the design windload. Guides shall be attached to adjoining construction with fasteners recommended by the manufacturer. Spacing of fasteners shall be as required to meet the minimum design windload.

### 2.1.5 Barrel

The barrel shall be steel pipe or commercial welded steel tubing of proper diameter for the size of curtain. Deflection shall not exceed 0.03 inch per foot of span. Ends of the barrel shall be closed with metal plugs, machined to fit the pipe. Aluminum plugs are acceptable on non-fire door barrels.

### 2.1.6 Springs

Oil tempered helical steel counter-balance torsion springs shall be installed within the barrel and shall be capable of producing sufficient torque to assure easy operation of the door curtain. Access shall be provided for spring tension adjustment from outside of the bracket without removing the hood.

### 2.1.7 Brackets

Brackets shall be of steel plates to close the ends of the roller-shaft housing, and to provide mounting surfaces for the hood. An operation bracket hub and shaft plugs shall have sealed prelubricated ball bearings.

### 2.1.8 Hoods

Hoods shall be steel with minimum bare metal thickness of 0.0219 inches formed to fit contour of the end brackets, and shall be reinforced with steel rods, rolled beads, or flanges at top and bottom edges. Multiple segment and single piece hoods shall be provided with support brackets of the manufacturer's standard design as required for adequate support.

### 2.1.9 Weatherstripping

Exterior doors shall be fully weatherstripped. A compressible and replaceable weather seal shall be attached to the bottom bar. Weather seal at door guides shall be continuous vinyl or neoprene, bulb or leaf type, or shall be nylon-brush type. A weather baffle shall be provided at the lintel or inside the hood. Weatherstripping shall be easily replaced without special tools.

### 2.1.10 Operation

Doors shall be operated by means of hand-chain. Equipment shall be designed and manufactured for usage in non-hazardous.

#### 2.1.10.1 Manual Hand-Chain Operation

Operation shall be by means of a galvanized endless chain extending to within 3 feet of floor. Reduction shall be provided by use of roller chain and sprocket drive or suitable gearing, to reduce the pull required on hand chain to not over 35 lbf. Gears shall be high grade gray cast iron.

#### 2.1.11 Locking

Locking shall consist of chain lock keeper, suitable for padlock by others, for chain operated doors.

#### 2.1.12 Finish

Steel slats and hoods shall be hot-dip galvanized G60 in accordance with ASTM A 653/A 653M, and shall be treated for paint adhesion and shall receive a factory baked-on prime coat for field finishing. The paint system shall withstand a minimum of 1500 hours without blistering, bubbling, or rust. Surfaces other than slats, hood, and faying surfaces shall be cleaned and treated to assure maximum paint adherence and shall be given a factory dip or spray coat of rust inhibitive metallic oxide or synthetic resin primer. Color shall be as selected by the Contracting Officer.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Doors shall be installed in accordance with approved detail drawings and manufacturer's instructions. Anchors and inserts for guides, brackets, hardware, and other accessories shall be accurately located. Upon completion, doors shall be free from warp, twist, or distortion. Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

#### 3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color shall be as indicated on the drawings.

-- End of Section --

## SECTION 08353

ACCORDION PARTITIONS  
10/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 90	(1999) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
ASTM E 413	(1987; R 1999) Rating Sound Insulation
ASTM F 793	(1993; R 1998) Standard Classification of Wallcovering by Durability Characteristics

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Accordion Partitions; G

Drawings containing complete schematic diagrams and details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

## SD-03 Product Data

## Accordion Partitions; G

Manufacturer's descriptive data, performance charts, catalog cuts, and installation instructions.

## SD-04 Samples

## Accordion Partitions; G

Manufacturer's standard color samples of specified surfaces and finishes.

#### SD-07 Certificates

##### Accordion Partitions

Certificate attesting that the materials meet the requirements specified and that partitions have specified acoustical and flame retardant properties, as determined by test.

#### SD-10 Operation and Maintenance Data

##### Accordion Partitions

Six complete copies of maintenance instructions explaining routine maintenance procedures including inspection, adjustments, lubrication, and cleaning. The instructions shall list possible breakdown, methods of repair, and a troubleshooting guide. Submit Data Package 1 in accordance with Section 01781, "Operation and Maintenance Data."

### 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in the manufacturer's original, unopened packages and shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

### 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Partition finishes shall have a Class A rating when tested in accordance with ASTM E 84.

#### 2.1.1 Vinyl Covering

The vinyl coated fabric shall conform to ASTM F 793, Category V, Type II (Medium duty). Covering shall have textured design.

#### 2.1.2 Hardware

Accordion partitions shall be furnished with grip handles with key locks on both sides. An upper latch with extended pulls shall be provided on units over 8 feet high. Hardware shall be anodized aluminum with a natural finish, chrome plated or painted finish.

#### 2.1.3 Sweep Strips

Sweep strips shall be vinyl or other material which will not crack or craze with severe usage. Sweep strip shall control STC to the specified rating.

#### 2.1.4 Track

Track shall be recessed and shall be of extruded aluminum or enamel finish steel. Track shall be manufacturer's standard product designed for the weight of door or partition furnished. Track sections shall be provided in the maximum lengths practicable, not less than 6 feet long except for narrow doors and at ends of runs where short length is required. Suitable joint devices such as interlocking keys shall be provided at each joint to provide permanent alignment of track.

#### 2.1.5 Ceiling Guard

Ceiling guard shall be provided when steel track is recessed. Guard shall be of metal of adequate thickness to protect the ceiling from damage by door operation and shall be provided with the door manufacturer's standard neutral-color applied finish. Guard on aluminum track shall be an integral part of the track.

#### 2.1.6 Vinyl Restrictions

Vinyls shall contain a non-mercury based mildewcide and shall be manufactured without the use of cadmium-based stabilizers.

### 2.2 ACCORDION PARTITIONS

Accordion partitions shall consist of top hung ball bearing carriers which support a system of hinged folding panels with a durable surface finish. Partitions shall have perimeter and jamb seals which shall provide the indicated STC rating. Ferrous metal parts shall be either cadmium plated or zinc coated and post shall have manufacturer's standard shop finish paint. Partitions shall be manually operated. Opening width shall be as shown.

#### 2.2.1 Pantograph Framework with Flexible Covering

Accordion partition shall have a steel pantograph hinged framework. Accordion partitions shall have a sound liner and shall meet the STC rating of 41 in accordance with ASTM E 90 and ASTM E 413. Intermediate pantographs shall be provided as required and partitions shall have a control divide to prevent flattening of the folds when the panel is fully extended. The covering shall be vinyl coated fabric.

#### 2.2.2 Steel Panels

Accordion partitions shall be vinyl clad cold rolled steel panels connected by full length steel hinges. Accordion partitions shall have an STC rating of 41.

### 2.3 COLOR

Color shall be as indicated.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's approved installation instructions.

-- End of Section --

## SECTION 08710

## DOOR HARDWARE

**02/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283 (1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM F 883 (1990) Padlocks

## BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1 (1997) Butts and Hinges (BHMA 101)

BHMA A156.2 (1996) Bored and Preassembled Locks and Latches (BHMA 601)

BHMA A156.3 (1994) Exit Devices (BHMA 701)

BHMA A156.4 (1992) Door Controls - Closers (BHMA 301)

BHMA A156.5 (1992) Auxiliary Locks & Associated Products (BHMA 501)

BHMA A156.6 (1994) Architectural Door Trim (BHMA 1001)

BHMA A156.7 (1988) Template Hinge Dimensions

BHMA A156.8 (1994) Door Controls - Overhead Holders (BHMA 311)

BHMA A156.13 (1994) Mortise Locks & Latches (BHMA 621)

BHMA A156.15 (1995) Closer Holder Release Devices

BHMA A156.16 (1997) Auxiliary Hardware

BHMA A156.17 (1993) Self Closing Hinges & Pivots

BHMA A156.18 (1993) Materials and Finishes (BHMA 1301)

BHMA A156.21 (1996) Thresholds

BHMA A156.22 (1996) Door Gasketing Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1999) Fire Doors and Fire Windows

NFPA 101 (1997) Life Safety Code

STEEL DOOR INSTITUTE (SDOI)

SDI 100 (1991) Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bldg Mat Dir (1999) Building Materials Directory

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Hardware schedule; G

Keying system

SD-03 Product Data

Hardware items; G

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule items, Data Package 1; G

Submit data package in accordance with Section 01781, "Operation and Maintenance Data."

SD-11 Closeout Submittals

Key bitting

1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hard- ware Item	Quan- tity	Size	Reference		Mfr. Name and Catalog No.	Key Con- trol Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designa- tion
			Publi- cation Type No.	Finish No.				
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1.4 KEY BITTING CHART REQUIREMENTS

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

- a. Complete listing of all keys (AA1, AA2, etc.).
- b. Complete listing of all key cuts (AA1-123456, AA2-123458).
- c. Tabulation showing which key fits which door.
- d. Copy of floor plan showing doors and door numbers.
- e. Listing of 20 percent more key cuts than are presently required in each master system.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

## PART 2 PRODUCTS

### 2.1 TEMPLATE HARDWARE

Hardware to be applied to metal or to prefinished doors shall be made to template. Promptly furnish template information or templates to door and frame manufacturers. Template hinges shall conform to BHMA A156.7. Coordinate hardware items to prevent interference with other hardware.

### 2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Such hardware shall bear the label of Underwriters Laboratories, Inc., and be listed in UL Bldg Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

### 2.3 HARDWARE ITEMS

Hinges, pivots, locks, latches, exit devices, bolts, and closers shall be clearly and permanently marked with the manufacturer's name or trademark where it will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

#### 2.3.1 Hinges

BHMA A156.1, 4 1/2 by 4 1/2 inches unless otherwise specified. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Other antifriction

bearing hinges may be provided in lieu of ball-bearing hinges.

### 2.3.2 Spring Hinges

BHMA A156.17.

### 2.3.3 Locks and Latches

#### 2.3.3.1 Mortise Locks and Latches

BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 7 by 2 1/4 inches with a bushing at least 1/4 inch long. Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Knobs and roses of mortise locks shall have screwless shanks and no exposed screws.

#### 2.3.4 Exit Devices

BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Touch bars shall be provided in lieu of conventional crossbars and arms. Provide escutcheons, not less than 7 by 2 1/4 inches.

#### 2.3.5 Exit Locks With Alarm

BHMA A156.5, Type E0431 (with full-width horizontal actuating bar) for single doors; Type E0431 (with actuating bar) or E0471 (with actuating bar and top and bottom bolts, both leaves active) for pairs of doors, unless otherwise specified. Provide terminals for connection to remote indicating panel.

#### 2.3.6 Cylinders and Cores

Provide cylinders for new locks, including locks provided under other sections of this specification. Cylinders shall be fully compatible with products of the Best Lock Corporation and shall have interchangeable cores which are removable by a special control key. The cores shall have seven pin tumblers and shall be factory set using the A4 system and F keyway. Submit a core code sheet with the cores. The cores shall be master keyed in one system for this project. Provide construction interchangeable cores.

#### 2.3.7 Keying System

The Government will provide permanent cylinders with cores and keys for mortise locksets, auxiliary locks, and exit devices. Cylinders shall be as manufactured by Best Lock Corp., Series 35H7 with a Best Lock - 3M lever design. The Contractor shall give written notice 90 days prior to the required delivery of the cylinders. Temporary cores and keys for the Contractor's use during construction, and for testing the locksets, shall be provided by the Contractor.

#### 2.3.8 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

##### 2.3.8.1 Knobs and Roses

In addition to meeting test requirements of BHMA A156.2 and BHMA A156.13, knobs, roses, and escutcheons shall be 0.050 inch thick if unreinforced.

If reinforced, outer shell shall be 0.035 inch thick and combined thickness shall be 0.070 inch, except knob shanks shall be 0.060 inch thick.

#### 2.3.8.2 Lever Handles

Provide lever handles in lieu of knobs. Lever handles for exit devices shall meet the test requirements of BHMA A156.13 for mortise locks. Lever handle locks shall have a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when a force in excess of that specified in BHMA A156.13 is applied to the lever handle. Lever handles shall return to within 1/2 inch of the door face.

#### 2.3.8.3 Texture

Provide knurled or abrasive coated knobs or lever handles for doors which are accessible to blind persons and which lead to dangerous areas.

#### 2.3.9 Door Bolts

BHMA A156.16. Provide dustproof strikes for bottom bolts, except for doors having metal thresholds. Automatic latching flush bolts: BHMA A156.3, Type 25.

#### 2.3.10 Closers

BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, except at storefront mounting, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

##### 2.3.10.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

#### 2.3.11 Overhead Holders

BHMA A156.8.

#### 2.3.12 Closer Holder-Release Devices

BHMA A156.15.

#### 2.3.13 Door Protection Plates

BHMA A156.6.

##### 2.3.13.1 Sizes of Mop and Kick Plates

Width for single doors shall be 2 inches less than door width; width for pairs of doors shall be one inch less than door width. Height of kick plates shall be 8 inches for flush doors and one inch less than height of bottom rail for panel doors. Height of mop plates shall be 4 inches.

#### 2.3.14 Door Stops and Silencers

BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

#### 2.3.15 Padlocks

ASTM F 883.

#### 2.3.16 Thresholds

BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

#### 2.3.17 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". A set shall include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weather stripped doors shall not exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283. Weather stripping shall be one of the following:

##### 2.3.17.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Aluminum shall be bronze anodized.

##### 2.3.18 Rain Drips

Extruded aluminum, not less than 0.08 inch thick, bronze anodized. Set drips in sealant conforming to Section 07920N, "Joint Sealants," and fasten with stainless steel screws.

##### 2.3.18.1 Door Rain Drips

Approximately 1 1/2 inches high by 5/8 inch projection. Align bottom with bottom edge of door.

##### 2.3.18.2 Overhead Rain Drips

Approximately 1 1/2 inches high by 2 1/2 inches projection, with length equal to overall width of door frame. Align bottom with door frame rabbet.

##### 2.3.19 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

#### 2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Fasteners exposed to weather shall be of nonferrous metal or stainless steel. Provide fasteners of type necessary to accomplish a permanent installation.

#### 2.5 FINISHES

BHMA A156.18. Hardware shall have BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless

steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except surface door closers which shall have aluminum paint finish, and except steel hinges which shall have BHMA 652 finish (satin chromium plated).

Hinges for exterior doors shall be stainless steel with BHMA 630 finish. Exit devices may be provided in BHMA 626 finish in lieu of BHMA 630 finish except where BHMA 630 is specified under paragraph entitled "Hardware Sets".

Exposed parts of concealed closers shall have finish to match lock and door trim. Hardware for aluminum doors shall be finished to match the doors.

## 2.6 KEY CABINET AND CONTROL SYSTEM

BHMA A156.5, Type required to yield a capacity (number of hooks) 50 percent greater than the number of key changes used for door locks.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

#### 3.1.1 Weather Stripping Installation

Handle and install weather stripping so as to prevent damage. Provide full contact, weather-tight seals. Doors shall operate without binding.

##### 3.1.1.1 Stop-Applied Weather Stripping

Fasten in place with color-matched sheet metal screws not more than 9 inches o.c. after doors and frames have been finish painted.

#### 3.1.2 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

### 3.2 FIRE DOORS AND EXIT DOORS

Install hardware in accordance with NFPA 80 for fire doors, NFPA 101 for exit doors.

### 3.3 HARDWARE LOCATIONS

SDI 100, unless indicated or specified otherwise.

- a. Kick and Armor Plates: Push side of single-acting doors. Both sides of double-acting doors.
- b. Mop Plates: Bottom flush with bottom of door.

### 3.4 KEY CABINET AND CONTROL SYSTEM

Locate where directed. Tag one set of file keys and one set of duplicate keys. Place other keys in appropriately marked envelopes, or tag each key.

Furnish complete instructions for setup and use of key control system. On tags and envelopes, indicate door and room numbers or master or grand master key.

### 3.5 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

### 3.6 HARDWARE SETS

#### HW-1

1 EA. CONTINUOUS HINGE	#919STST ZERO, 630
1 EA. EXIT (7150 D H S YALE)	TYPE 28 FUNCTION 01 WITH DELAYED EGRESS, 630
1 EA. POWER TRANSFER	AS REQUIRED
1 EA. POWER SUPPLY	AS REQUIRED
1 EA. DOOR CLOSER	CO2021 PT1,4G,4D, 689
1 EA. KICKPLATE	J102, 630
1 EA. THRESHOLD	J36130, AL
1 SET WEATHERSTRIP	R0Y154
1 EA. DOOR BOTTOM	R3Y535
1 EA. DRIP CAP	NGP 101VA OR EQUAL

#### HW-2

2 EA. CONTINUOUS HINGES	#919STST ZERO, 630
2 EA. EXITS (7150 X 691 SM EX YALE)	TYPE 28 FUNCTION 08 ELECTIFIED TRIM, 630
2 EA. CYLINDERS	AS REQUIRED
2 EA. MAGNETIC LOCKS	1511/1523 SECURITY DOOR CONTROLS
1 EA. POWER SUPPLY	634RF SECURITY DOOR CONTROLS
2 EA. POWER TRANSFER	AS REQUIRED
2 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
2 EA. KICKPLATES	J102, 630
1 EA. MULLION CARD READER BY OTHERS	TYPE 22
1 EA. THRESHOLD	J36130, AL
1 SET WEATHERSTRIP	R0Y154
1 EA. DOOR BOTTOM	R3Y535

#### HW-3

6 EA. HINGES	A5111, 4.5" X 4.5" NRP, 630
2 EA. EXITS (7150 D H S YALE)	TYPE 28 FUNCTION 01, 630
2 EA. CYLINDERS	AS REQUIRED
2 EA. POWER TRANSFERS	AS REQUIRED
1 EA. POWER SUPPLY	AS REQUIRED
2 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
2 EA. KICKPLATES	J102, 630
1 SET SMOKE SEAL	R3Y535

1 EA. MULLION TYPE 22

## HW-4

3 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 2 EA. CYLINDERS AS REQUIRED  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D,4G, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. THRESOLD J36130

## HW-5

4 EA. HINGES A8111, 5" X 5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 2 EA. CYLINDERS AS REQUIRED  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESOLD J36130 (DOOR: C103A)  
 CARD READER BY OTHERS

## HW-5A

4 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 2 EA. CYLINDERS AS REQUIRED  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESOLD J36130  
 CARD READER BY OTHERS

## HW-6

3 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D,4G, 689  
 1 EA. KICKPLATES J102, 630  
 CARD READER BY OTHERS

## HW-7

3 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 FO7, 626  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 SET SMOKE SEAL R3Y535  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESOLD J36130

## HW-8

3 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F21, 626  
 1 EA. CYLINDER AS REQUIRED  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESHOLD J32100  
 DOORS:A203B,A204A,B201A,B201B,B202A,B202B,C102A,C201A,

## HW-9

3 EA. HINGES A8111, 4.5" X 4.5" NRP, 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 2 EA. CYLINDER AS REQUIRED  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESHOLD J32130  
 DOORS:A114B,B101A,B101B  
 CARD READER BY OTHERS

## HW-10

3 EA. HINGES A8111, 4.5" X 4.5", 652  
 1 EA. LOCKSET SERIES 1000 F14, 626  
 2 EA. CYLINDERS AS REQUIRED  
 1 EA. MAGNETIC LOCK 1511/1522 SERCURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 631RF SECURITY DOOR CONTROLS  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. WALL STOP L02251, 626  
 1 EA. THRESHOLD J32130

## HW-11

8 EA. HINGES A5111, 4.5" X 4.5" NRP, 630  
 2 EA. EXITS TYPE 28 FUNCTION O8 ELECTIFIED TRIM, 630  
 (7150 X 691 SM EX YALE)  
 2 EA. CYLINDERS AS REQUIRED  
 2 EA. MAGNETIC LOCKS 1511/1523 SECURITY DOOR CONTROLS  
 1 EA. POWER SUPPLY 634RF SECURITY DOOR CONTROLS  
 2 EA. POWER TRANSFER AS REQUIRED  
 2 EA. DOOR CLOSERS C02021 PT1, 4C,4D,4G, 689  
 2 EA. KICKPLATES J102, 630  
 1 EA. THRESHOLD J361300  
 1 EA. MULLION TYPE 22  
 CARD READER BY OTHERS

## HW-12

3 EA. HINGES A8111, 4.5" X 4.5", 652  
 1 EA. PULL PLATE J402 (J12 HAGAR), 630  
 1 EA. PUSH PLATE J402, 630  
 1 EA. DOOR CLOSERS C02021 PT1, 4C,4D, 689  
 1 EA. KICKPLATES J102, 630  
 1 EA. WALL STOP L02251, 626

## HW-13

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. LOCKSET	SERIES 1000 F07, 626
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATE	J102, 630

## HW-14

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. LOCKSET	SERIES 1000 F14, 626
2 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCK	1511/1522 SERCURITY DOOR CONTROLS
1 EA. POWER SUPPLY	631RF SECURITY DOOR CONTROLS
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D, 689
1 EA. KICKPLATES	J102, 630
1 EA. WALL STOP	L02251, 626
1 EA. THRESOLD	J36130
CARD READER BY OTHERS	

## HW-15

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. LOCKSET	SERIES 1000 F14, 626
2 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCK	1511/1522 SERCURITY DOOR CONTROLS
1 EA. POWER SUPPLY	631RF SECURITY DOOR CONTROLS
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESOLD	J36130
CARD READER BY OTHERS	

## HW-16

3 EA. HINGES	A5111, 4.5" X 4.5" NRP, 630
1 EA. COMBNATION LOCK	CDX08
1 EA. LOCKSET	SERIES 1000 F14, 626
2 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCK	1511/1522 SERCURITY DOOR CONTROLS
1 EA. POWER SUPPLY	631RF SECURITY DOOR CONTROLS
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESHOLD	J32130

## HW-17

NOT USED

## HW-18

NOT USED

## HW-19

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. LOCKSET	SERIES 1000 F14, 626
2 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCK	1511/1522 SERCURITY DOOR CONTROLS
1 EA. POWER SUPPLY	631RF SECURITY DOOR CONTROLS

1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESOLD	J36130
CARD READER BY OTHERS	

## HW-20

6 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 PR. FLUSH BOLTS	TYPE 25, 630
1 EA. DUST PROOF STRIKE	L04021, 630
1 EA. LOCKSET	SERIES 1000 F07, 626
1 EA. COORDINATOR	TYPE 21B, 600
1 EA. THRESOLD	J36130

## HW-21

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. LOCKSET	SERIES 1000 F04, 626
1 EA. CYLINDERS	AS REQUIRED
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESOLD	J36130

## HW-22

6 EA. HINGES	A8111, 4.5" X 4.5" NRP, 630
2 EA. EXITS	TYPE 28 FUNCTION 01, 630
2 EA. DOOR CLOSERS/HOLDER	C00241, 689
2 EA. KICKPLATES	J102, 630
1 SET SMOKE SEAL	R3Y535
1 EA. MULLION	TYPE 22

## HW-23

3 EA. HINGES	A5111, 4.5" X 4.5" NRP, 630
1 EA. EXITS	TYPE 28 FUNCTION 08 ELECTIFIED TRIM, 630
(7150 X 691 SM EX YALE)	
1 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCKS	1511/1523 SECURITY DOOR CONTROLS
1 EA. POWER SUPPLY	634RF SECURITY DOOR CONTROLS
1 EA. POWER TRANSFER	AS REQUIRED
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESHOLD	J361300
CARD READER BY OTHERS	

## HW-24

3 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 EA. EXITS	TYPE 28 FUNCTION 01, 630
1 EA. MAGNETIC LOCKS	1511/1523 SECURITY DOOR CONTROLS
1 EA. POWER SUPPLY	634RF SECURITY DOOR CONTROLS
1 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. KICKPLATES	J102, 630
1 EA. THRESHOLD	J361300

## HW-25

6 EA. HINGES	A8111, 4.5" X 4.5" NRP, 630
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2 EA. EXITS	TYPE 28 FUNCTION 01, 630
2 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
2 EA. KICKPLATES	J102, 630
1 SET SMOKE SEAL	R3Y535
1 EA. MULLION	TYPE 22

## HW-26

6 EA. HINGES	A8111, 4.5" X 4.5" NRP, 652
1 PR. FLUSH BOLTS	TYPE 25, 630
1 EA. DUST PROOF STRIKE	L04021, 630
1 EA. LOCKSET	SERIES 1000 F14, 626
2 EA. CYLINDERS	AS REQUIRED
1 EA. MAGNETIC LOCKS	1511/1523 SECURITY DOOR CONTROLS
1 EA. POWER SUPPLY	634RF SECURITY DOOR CONTROLS
2 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
1 EA. COORDINATOR	TYPE 21B, 600

CARD READER BY OTHERS

## HW-27

6 EA. HINGES	A8111, 4.5" X 4.5", 652
2 EA. PULL PLATE	J402 (J12 HAGAR), 630
2 EA. PUSH PLATE	J402, 630
2 EA. DOOR CLOSERS	C02021 PT1, 4C,4D,4G, 689
2 EA. KICKPLATES	J102, 630

## HW-28

2 EA. POWER ASSIST OPERATORS	PER BHMA A156.19-1997
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## HW-29

2 EA. PADLOCKS	AS REQUIRED
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## NOTES:

1. CARD READERS BY OTHERS
2. SUPPLY WIRING DIRGRAMS FOR ALL PRODUCTS SUPPLIED

-- End of Section --

## SECTION 08810A

GLASS AND GLAZING  
05/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 669 (1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash

ASTM C 1036 (1991; R 1997) Flat Glass

ASTM C 1048 (1997b) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

ASTM C 1172 (1996e1) Laminated Architectural Flat Glass

ASTM D 395 (1998) Rubber Property - Compression Set

ASTM E 119 (1998) Fire Tests of Building Construction and Materials

ASTM E 773 (1997) Accelerated Weathering of Sealed Insulating Glass Units

ASTM E 774 (1997) Classification of the Durability of Sealed Insulating Glass Units

ASTM E 1300 (1998) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

## SEALED INSULATING GLASS MANUFACTURERS ASSOCIATION (SIGMA)

SIGMA TM 3000 (1997) Glazing Guidelines for Sealed Insulating Glass Units

SIGMA TM 3001 (1990) Sloped Glazing

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201 Safety Standard for Architectural Glazing

## Materials

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-378 (Basic) Putty Linseed Oil Type, (for  
Wood-Sash-Glazing)

## GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA (GM) Glazing Manual (1997) Glazing Manual

GANA (SM) (1990) Sealant Manual

GANA Standards Manual (1995) Engineering Standards Manual

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1999) Fire Doors and Fire Windows

NFPA 252 (1995) Fire Tests of Door Assemblies

NFPA 257 (1996) Fire Tests for Window and Glass  
Block Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Installation; G, AE

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

## SD-03 Product Data

Wire glassed; G, AE  
Insulating Glass; G, AE  
Glazing Accessories; G, AE  
Laminated glass; G, AE

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

## SD-04 Samples

Insulating Glass

Two 8 x 10 inch samples of each of the following: tinted glass, spandrel glass, fire-resistant glass, laminated glass, wire glass, and insulating glass units.

## SD-07 Certificates

### Insulating Glass

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

#### 1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

#### 1.4 DELIVERY, STORAGE AND HANDLING

Glazing compounds shall be delivered to the site in the manufacturer's unopened containers. Glass shall be stored indoors in a safe, well ventilated dry location in accordance with manufacturer's instructions, and shall not be unpacked until needed for installation. Glass shall not be stored on site over 1 month.

#### 1.5 PROJECT/SITE CONDITIONS

Glazing work shall not be started until outdoor temperature is above 40 degrees F and rising, unless procedures recommended by glass manufacturer and approved by Contracting Officer are made to warm the glass and rabbet surfaces. Ventilation shall be provided to prevent condensation of moisture on glazing work during installation. Glazing work shall not be performed during damp or raining weather.

#### 1.6 WARRANTY

##### 1.6.1 Insulating Glass

Manufacturer shall warrant the insulating glass to be free of fogging or film formation on the internal glass surfaces caused by failure of the hermetic seal for a period of 10 years from Date of Substantial Completion. Warranty shall be signed by manufacturer.

##### 1.6.2 Laminated Glass

Manufacturer shall warrant the laminated glass for defects developed from normal use that are attributable to the manufacturing process and not to glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's direction. Defects include edge separation, delamination, materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standards.

##### 1.6.3 Monolithic Opacified Spandrel

Manufacturer shall warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

## PART 2 PRODUCTS

## 2.1 ROLLED GLASS

### 2.1.1 Wired Glass

Wired glass shall be Type II flat type, Class 1 - translucent, Quality q8 - glazing, Form 1 - wired and polished both sides, conforming to ASTM C 1036.

Wire mesh shall be polished stainless steel Mesh 2 - square. Wired glass for fire-rated windows shall bear an identifying UL label or the label of a nationally recognized testing agency, and shall be rated for 45 minutes when tested in accordance with NFPA 257. Wired glass for fire-rated doors shall be tested as part of a door assembly in accordance with NFPA 252. Color shall be clear.

## 2.2 INSULATING GLASS

Insulating glass shall be Class A preassembled units of dual-seal construction consisting of lites of glass separated by an aluminum, steel, or stainless steel, spacer and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone. Glass types shall be as follows:

### 2.2.1 Insulating Glass

Glass for two-pane insulating units shall be 1/4 inch clear heat strengthened laminated glass inner pane as specified, 1/2 inch airspace, and 1/4 inch tempered bronze tinted glass as specified. Glass performance shall be R-Value/Winter Nighttime .48.

## 2.3 HEAT-TREATED GLASS

Heat-treated glass shall conform to the following requirements.

### 2.3.1 Tempered Glass

Tempered glass shall be kind FT fully tempered transparent flat type, Class 1-clear and 2-tinted, Condition A uncoated surface, Quality q3 - glazing select, 55 percent light transmittance for bronze tint, .74 percent shading coefficient for bronze tint conforming to ASTM C 1048 and GANA Standards Manual. Color shall be clear and bronze as indicated. Tempered glass shall be 1/4 inch thick.

### 2.3.2 Heat-Strengthened Glass

Heat-strengthened glass shall be kind HS heat-strengthened transparent flat type, Class 1-clear, Condition A uncoated surface, Quality q3 - glazing select, conforming to ASTM C 1048. Color shall be clear.

## 2.4 LAMINATED GLAZINGS

### 2.4.1 Laminated Glass

Laminated glass shall consist of two layers of heat strengthened glass, Class 1-clear Quality q3 - glazing select, conforming to ASTM C 1036. Glass shall be bonded together with 0.030 inchthick PVB interlayer under

pressure, conforming to requirements of 16 CFR 1201 and ASTM C 1172. Color shall be clear.

## 2.5 INSULATING SPANDREL GLASS

### 2.5.1 Ceramic-Coated Heat-Treated Spandrel Glass

Condition B (spandrel glass, one surface ceramic coated), Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), with ceramic coating applied to third surface of insulated glass pane and complying with the following requirements: Applied to heat strengthened laminated glass inner pane of insulated glass. Outer pane of insulating spandrel glass shall be 1/4 inch thick bronze tinted, tempered glass.

#### 2.5.1.1 Color

Color shall be bronze.

#### 2.5.1.2 Adhered Backing

Laminate manufacturer's standard adhered scrim backing to ceramic-coated surface; provide backed units identical to materials which, while possibly developing cracks and fissures, show no shear nor develop any openings large enough for the unobstructed penetration of a 3 inch diameter sphere when tested by an approved independent testing laboratory in the following manner:

- a. Mount test specimen consisting of three glass assemblies, 34 inches by 76 inches (plus zero or minus 3/16 inch), for testing as specified in ANSI Z-97.1.
- b. Expose specimen to 100 cycles of the following conditions:
  - (1) One hour at 0 deg. F (-17.8 deg. C), ambient humidity.
  - (2) Three hours increase from 0 deg. F (-17.8 deg. C) to 140 deg. F (60 deg. C), 95 to 100 percent relative humidity.
  - (3) One hour at 140 deg. F (60 deg. C), 95 to 100 percent relative humidity.
  - (4) Three hours decrease from 140 deg. F (60 deg. C) to 0 deg. F (-17.8 deg. C), ambient humidity.
- c. Break glass by spring-loaded prick punch at midpoint of either vertical edge.
- d. After breaking glass, subject it to pressure of 4 lbf per sq. ft. for 5 minutes to simulate wind load.

## 2.6 FIRE RESISTANT GLASS

Fire resistant glass shall be laminated Type I transparent flat type, Class 1-clear. Glass shall have a 60 minute rating when tested in accordance with ASTM E 119. Glass shall be permanently labeled with appropriate markings.

## 2.7 GLAZING ACCESSORIES

### 2.7.1 Preformed Tape

Preformed tape shall be elastomeric rubber extruded into a ribbon of a width and thickness suitable for specific application. Tape shall be of type which will remain resilient, have excellent adhesion, and be chemically compatible to glass, metal, or wood.

### 2.7.2 Structural Sealant (For all Aluminum Frame Windows and Doors)

Sealant shall be structural sealant conforming to ASTM C 1184, of type chemically compatible with setting blocks, and sealants used in manufacturing insulating glass. Color of sealant shall be as selected.

### 2.7.3 Preformed Channels

Neoprene, vinyl, or rubber as recommended by the glass manufacturer for the particular condition. Channels where used shall be chemically compatible with adjacent materials and sealants.

### 2.7.4 Putty and Glazing Compound

Glazing compound shall conform to ASTM C 669 for face-glazing metal sash. Putty shall be linseed oil type conforming to CID A-A-378 for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

### 2.7.5 Setting and Edge Blocking

Neoprene setting blocks shall be dense extruded type conforming to ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer.

### 2.7.6 Applied Insulation

Rigid insulation shall be applied to inside (4th side) face of spandrel glass adhered to the glass without glazing stops. See Section 06100A ROUGH CARPENTRY for insulation.

## PART 3 EXECUTION

### 3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA (GM) Glazing Manual, GANA Standards Manual, GANA (SM), SIGMA TM 3001, SIGMA TM 3000 and glass manufacturer's recommendations including size, squareness, offsets at corners, presence and function of weep system, face and edge clearance requirements and effective sealing between joints of glass-framing members. Detrimental materials shall be removed from glazing rabbet and glass surfaces and wiped dry with solvent. Glazing surfaces shall be dry and free of frost.

### 3.2 INSTALLATION

Glass and glazing work shall be performed in accordance with approved shop drawings, GANA (GM) Glazing Manual, GANA Standards Manual, GANA (SM), SIGMA

TM 3001, SIGMA TM 3000 glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire resistive glass shall be installed in accordance with NFPA 80. Edges and corners shall not be ground, nipped or cut after leaving factory. Springing, forcing or twisting of units during installation will not be permitted.

### 3.3 CLEANING

Upon completion of project, outside surfaces of glass shall be washed clean and the inside surfaces of glass shall be washed and polished in accordance with glass manufacturer's recommendations.

### 3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

-- End of Section --

## SECTION 09100N

## METAL SUPPORT ASSEMBLIES

**09/99**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(1997; Rev. A) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(1998) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C 645	(1998) Nonstructural Steel Framing Members
ASTM C 754	(1997) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 841	(1997) Installation of Interior Lathing and Furring

## METAL LATH/STEEL FRAMING ASSOCIATION (ML/SFA)

ML/SFA MLF	(1991) Metal Lathing and Furring
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## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

## SD-02 Shop Drawings

Metal support systems; G, AE

Submit for the erection of metal framing, furring, and ceiling suspension systems. Indicate materials, sizes, thicknesses, and fastenings.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations. Storage area shall permit easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

## PART 2 PRODUCTS

## 2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A 653/A 653M, G-60; aluminum coating ASTM A 463/A 463M, T1-25; or a 55-percent aluminum-zinc coating.

### 2.1.1 Materials for Attachment of Lath

#### 2.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C 841.

#### 2.1.1.2 Nonload-Bearing Wall Framing

ML/SFA MLF.

### 2.1.2 Materials for Attachment of Gypsum Wallboard

#### 2.1.2.1 Suspended and Furred Ceiling Systems

ASTM C 645.

#### 2.1.2.2 Nonload-Bearing Wall Framing and Furring

ASTM C 645, but not thinner than 0.0179 inch thickness furring, 0.0329 inch studs, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures. Flange of studs shall be 1-5/8 inches wide for 3-1/2 inch studs and 1-3/8 inches wide for 6 and 8 inch studs.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Systems for Attachment of Lath

##### 3.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C 841, except as indicated otherwise.

##### 3.1.1.2 Nonload-Bearing Wall Framing

ML/SFA MLF, except that framing members shall be 16 inches o.c. unless indicated otherwise. Brace walls in accordance with manufacturers recommendations for lateral stability and as indicated. Diagonal bracing shall be cold rolled U-channel horizontally through stud, diagonal strapping and/or horizontal blocking with horizontal strapping. Spacing shall be as required by manufacturer. Tops of stud wells shall also be braced as indicated.

#### 3.1.2 Systems for Attachment of Gypsum Wallboard

##### 3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C 754, except that framing members shall be 16 inches o.c. unless indicated otherwise.

##### 3.1.2.2 Nonload-Bearing Wall Framing and Furring

ASTM C 754, except as indicated otherwise. Brace walls in accordance with manufacturers recommendation and as indicated.

### 3.1.2.3 Furring Structural Steel Columns

Install studs and support angles for erection of gypsum wallboard around structural steel columns as indicated.

## 3.2 ERECTION TOLERANCES

Framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/4 inch in 8 feet from a straight line;
- c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/8 inch in 8 feet from a straight line;
- c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

## SECTION 09215A

## VENEER PLASTER

11/95

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 472	(1999) Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 587	(1997) Gypsum Veneer Plaster
ASTM C 588/C 588M	(1999) Gypsum Base for Veneer Plasters
ASTM C 645	(2000) Nonstructural Steel Framing Members
ASTM C 754	(1999a) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 844	(1999) Application of Gypsum Base to Receive Gypsum Veneer Plaster
ASTM C 1002	(1998) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Approved Detail Drawings

Drawings showing ceiling framing and furring, special wall framing, and framed openings.

## SD-03 Product Data

## Materials

The manufacturer's descriptive data for veneer plastering materials.

Manufacturer's installation instructions for veneer plastering materials.

#### SD-07 Certificates

Fire Resistive Construction  
Steel Framing, Furring and Related Items

Certificates attesting that the steel framing meets the specified requirements, and that fire-resistive partitions meet the ratings shown.

### 1.3 GENERAL REQUIREMENTS

The work shall conform to ASTM C 587, ASTM C 754, and ASTM C 844. Gypsum veneer plaster shall be applied as a two component system over a special gypsum base. The veneer plaster, gypsum base, and joint reinforcement shall be products of the same manufacturer. The extent and location of veneer plaster shall be as shown on the approved detail drawings. Metal framing is specified herein.

### 1.4 DELIVERY AND STORAGE

Plaster materials shall be delivered and stored in the manufacturer's original unopened containers. Materials shall be stored off the ground within a completely enclosed structure or completely enclosed within a weathertight covering. Gypsum base and gypsum board shall be stored flat so as to prevent warping, shall be protected from excessive exposure to sunlight, and shall have bundling tape intact immediately prior to use.

### 1.5 SCHEDULING

Installation shall commence only after the area scheduled for veneer plaster work is completely weathertight. The heating, ventilating, and air-conditioning systems should be complete and in operation prior to application of the plaster. If the mechanical systems cannot be activated before veneer plastering is begun, the plastering may proceed in accordance with an approved plan to maintain the environmental conditions specified below. Plaster shall be applied prior to the installation of finish flooring and acoustic ceilings.

### 1.6 ENVIRONMENTAL REQUIREMENTS

The gypsum base shall not be exposed to excessive sunlight prior to plaster application, as bond failure of the plaster may result. A continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F shall be maintained for at least one week prior to the application of veneer plaster, while the plastering is being done, and for at least one week after the plaster is set. Air supply and distribution devices shall be shielded to prevent any uneven flow of air across the plastered surfaces. The ventilation rate shall be adjusted to prevent rapid drying.

### 1.7 FIRE RESISTIVE CONSTRUCTION

Partitions and ceilings indicated to be of fire resistive construction shall be built in compliance with designs as shown on the drawings. Fire-rated assembly shall be for the Design Numbers indicated.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Materials shall conform to the requirements specified below. Miscellaneous items not otherwise specified shall be as recommended by the veneer plaster system manufacturer and approved prior to use. Powder driven fasteners may be used only when approved in writing.

#### 2.1.1 Steel Framing, Furring, and Related Items

Non-load bearing steel studs, framing and related items shall be in accordance with ASTM C 645. See also Section 05400 COLD-FORMED STEEL FRAMING for framing at exterior walls.

#### 2.1.2 Vapor Retarder

Vapor retarder shall consist of foil-backed gypsum base, or 4 mil thick polyethylene.

#### 2.1.3 Gypsum Base

Gypsum base for veneer plaster shall be in accordance with ASTM C 588/C 588M, regular Type C, 48 inches wide, 1/2 inch thick. Edges shall be square, rounded, or tapered as recommended by the veneer plaster manufacturer.

#### 2.1.4 Gypsum Veneer Plaster

Gypsum veneer plaster shall be in accordance with ASTM C 587. Minimum compressive strength of finish coat plaster shall be 2500 psi in accordance with ASTM C 472. Plaster finish shall be smooth trowel finish.

#### 2.1.5 Joint Reinforcement

Joint reinforcement for steel studs shall be minimum 2 in wide perforated cross fibered paper tape as recommended by the veneer manufacturer.

#### 2.1.6 Joint Compound

Joint compound shall be in accordance with ASTM C 475.

#### 2.1.7 Screws

Screws for the installation of gypsum board shall be in accordance with ASTM C 1002, and shall be type appropriate to use.

#### 2.1.8 Cornerbead and Edge Trim

Cornerbead and edge trim shall be corrosion protective-coated steel or vinyl as recommended by the veneer plaster manufacturer. Flanges shall be free of any material that would adversely affect bonding of the plaster.

## PART 3 EXECUTION

### 3.1 STEEL FRAMING

The installation of steel framing shall conform to ASTM C 754. Framing shall be spaced at 16 inches on center maximum. Partitions shall support applied loads such as cabinets and counters without exceeding the permitted deflection.

### 3.1.1 Partition Framing System

Metal nonload bearing framing and furring system shall be capable of carrying a transverse load of 5 psf without exceeding either the allowable stress or a deflection of  $L/240$ . Studs shall be 0.0179 inch minimum thickness for partitions having the same material and the same material thickness on both sides. For partitions using 0.0179 inch thick studs, the surfacing material shall cover the full height of the partition on both sides, or the stud flanges shall be otherwise supported to insure rigidity. Studs shall be 0.0329 inch minimum thickness for partitions having different materials or different material thickness on the two sides. At partition ends, corners, and intersections, and at jambs of openings, studs shall be fastened to runners with screws. Framing at tops of walls shall be fit between flanges and temporarily secured to top runner. Screws shall be backed out of top runner as veneer plaster gypsum base is applied. Sufficient gap between top of stud and top of top runner shall be provided to prohibit axial loading of metal framing from structure above.

### 3.1.2 Special Framing

Framing for beams, columns, soffits, and other special items shall be built to the sizes, shapes, or forms indicated and shall be rigidly secured at each intersection with wallboard screws.

### 3.1.3 Ceiling Openings

Support members shall be provided at ceiling openings such as required for access panels, recessed light fixtures, and for air supply or exhaust. Support members of not less than 1-1/2 inch main runner channels and suspension wires or straps shall be located to provide at least the minimum support specified herein for furring and wallboard attachment. Intermediate structural members, although not a part of the structural system, shall be provided for attachment or suspension of support members.

### 3.1.4 Wall Openings

At wall openings the framing system shall provide for the installation and anchorage of the required subframes or finish frames. Steel frames shall be securely attached with wallboard screws through built-in anchors to the nearest stud on each side of the opening. Double studs shall be provided at both jambs of all door openings. The doubled studs shall be 0.0329 inch minimum thickness. For doors over 4 feet wide, double doors, and for extra-heavy doors, the doubled studs shall be 20 gauge minimum thickness. Door frames shall be fully grouted at the jamb locations with joint compound applied just prior to application of gypsum base.

### 3.1.5 Blocking

Blocking shall be provided as necessary for mounted equipment. Blocking shall be metal and shall be cut to fit between framing members. Blocking shall be rigidly anchored to the framing members. Under no circumstances will accessories or other wall mounted equipment be anchored directly to the veneer plaster system.

### 3.2 APPLICATION OF GYPSUM BASE

Gypsum base shall be applied to framing and furring members in accordance with ASTM C 844 and the requirements specified and shall be the type and thickness required by the wall design. Gypsum wallboard may be used for the base ply in two-ply construction. Gypsum base and wallboard shall be of maximum practical length, using full length boards for vertical application. Installation shall be with separate boards in moderate contact without forcing in place. Direction of application shall be arranged so leading edge of gypsum base is attached to open edge of stud flange. Boards shall be installed tight against the framing so as to eliminate any offset in the face plane between adjoining boards. End joints of adjoining boards shall be staggered. Abutting end and edge joints shall be neatly fitted. Boards shall be cut as required to make neat close joints around openings. Gypsum base shall be adhered to gypsum wallboard with an adhesive. In multilayer construction, joints shall be offset between layers. Joints on opposite faces of the partition shall be offset.

#### 3.2.1 Control Joints

Control joints in ceilings and walls shall be one piece manufactured products designed for use with a veneer plaster system. Control joints shall be installed where indicated.

#### 3.2.2 Vapor Retarder

Foil-backed gypsum base shall be installed with the reflective surface placed against the framing members. Polyethylene vapor retarder shall be installed with joints over framing members, and with joints lapped the full width of the framing members.

### 3.3 JOINT REINFORCEMENT

Interior angles and flat joints in the gypsum base shall be reinforced prior to application of the veneer plaster. Self-adhering mesh shall not be used. Reinforcement shall be a special mesh reinforcing strip embedded in veneer plaster, or gypsum wallboard joint tape embedded in joint compound.

#### 3.3.1 Fiber Mesh Reinforcing

Mesh reinforcing strips shall be thoroughly embedded in veneer plaster, so that embedment material is both under and covering the reinforcement. Areas of reinforcement shall be allowed to preset, and shall be left rough enough for proper bonding of the plaster coat. Reinforcement shall be set, but not dry, before the application of veneer plaster over the entire area.

#### 3.3.2 Perforated Paper Tape Reinforcing

The paper tape shall be pressed into a bedding coat of setting type joint compound, and immediately covered with a skim coat of the same compound. After the bedding and skim coats are set, a fill coat of joint compound shall be applied. The reinforcement shall be set and dry before application of veneer plaster over the entire area.

### 3.4 APPLICATION OF GYPSUM VENEER PLASTER

Gypsum veneer plaster shall be applied in accordance with ASTM C 587, and the manufacturer's approved installation instructions where such instructions are additional to or more restrictive than the requirements of ASTM C 587. Minimum plaster thickness shall be as recommended by the manufacturer, but shall in no case be less than 1/16 inch for base coat and 1/16 inch for finish coat of a two-component system.

#### 3.4.1 Mixing

The mixer shall be cleaned between batches to avoid accelerating the setting time. Other plaster materials shall not be added to modify the properties of the veneer plaster. When extreme conditions so demand, small quantities of commercial retarder or accelerator may be added to the mixing water to adjust setting time. The use of retarder or accelerator shall be in strict conformance with the veneer plaster manufacturer's recommendations.

#### 3.4.2 Base Coat

The base coat shall be scratched in, then immediately doubled back using material from the same batch. Voids and imperfections shall be filled, and the plaster leveled to a true surface without the application of water. The final surface shall be roughened to provide a rough and open surface for bonding by brushing or cross-raking with a fine wire rake after the basecoat material has become firm. For application of finish coat, the base coat shall be set and partially dry. If the base coat is totally dry, it shall be dampened before finish coat application.

#### 3.4.3 Finish Coat

The finish coat shall be scratched in, then immediately doubled back using material from the same batch. The surface shall be lightly troweled without the addition of water, filling voids and imperfections and eliminating surface irregularities. When the plaster has become firm and prior to set, the surface shall be smoothed; as required, to achieve the indicated finish using water sparingly.

### 3.5 CLEANUP AND PATCHING

Plaster splashes shall be removed from adjacent surfaces. Defects in the veneer plaster shall be repaired. Plaster surfaces shall be smooth and clean, and in condition to receive the finishing materials that will be applied.

-- End of Section --

## SECTION 09250

## GYPSUM BOARD

**11/01**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 36/C 36M	(1999) Gypsum Wallboard
ASTM C 442/C 442M	(1999; Rev. A) Gypsum Backing Board and Coreboard
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 840	(2001) Application and Finishing of Gypsum Board
ASTM C 954	(2000) Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C 1002	(2000) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases
ASTM C 1047	(1999) Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C 1178/C 1178M	(1999) Glass Mat Water-Resistant Gypsum Backing Board
ASTM C 1396/C 1396M	(2000) Standard Specification for Gypsum Board

## GYPSUM ASSOCIATION (GA)

GA 214	(1996) Recommended Levels of Gypsum Board Finish
GA 216	(2000) Application and Finishing of Gypsum Board

## UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(2000) Fire Resistance Directory
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## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

### SD-03 Product Data

Type C fire resistant gypsum board

Regular gypsum board

Glass Mat Water-Resistant Gypsum Tile Backing Board

Accessories

Submit for each type of gypsum board.

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

### 1.3.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation.

### 1.3.3 Handling

Neatly stack gypsum board flat to prevent sagging or damage to the edges, ends, and surfaces.

## 1.4 ENVIRONMENTAL CONDITIONS

### 1.4.1 Temperature

Maintain a uniform temperature of not less than 50 degrees F in the structure for at least 48 hours prior to, during, and following the application of gypsum board, cementitious backer units, and joint treatment materials, or the bonding of adhesives.

### 1.4.2 Exposure to Weather

Protect gypsum board products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

## 1.5 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of 5 years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of 5 years of documented successful

experience.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Conform to specifications, standards and requirements specified herein. Provide gypsum board types and joint treating materials manufactured from asbestos free materials only.

#### 2.1.1 Gypsum Board

ASTM C 36/C 36M and ASTM C 1396/C 1396M.

##### 2.1.1.1 Regular

48 inches wide, 1/2 inch thick, tapered.

##### 2.1.1.2 Type C (Special Fire-Resistant)

48 inches wide, 1/2 inch thick, tapered edges.

#### 2.1.2 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C 1178/C 1178M

##### 2.1.2.1 Regular

48 inches wide, 1/2 inch thick, square edges.

#### 2.1.3 Gypsum Sheathing

Gypsum sheathing is specified in Section 06100 ROUGH CARPENTRY.

#### 2.1.4 Joint Treatment Materials

ASTM C 475.

##### 2.1.4.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

##### 2.1.4.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

##### 2.1.4.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

##### 2.1.4.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

##### 2.1.4.5 Joint Tape

Cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape

recommended by the manufacturer.

#### 2.1.5 Fasteners

##### 2.1.5.1 Screws

ASTM C 1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, and steel framing members less than 0.033 inch thick. ASTM C 954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick.

##### 2.1.5.2 Staples

No. 16 USS gage flattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

<u>Length of Legs (inch)</u>	<u>Thickness of Gypsum Board (inch)</u>
1 1/8	1/2

#### 2.1.6 Adhesives

Do not use adhesive containing benzene, carbon tetrachloride, or trichloroethylene.

##### 2.1.6.1 Adhesive for Fastening Gypsum Board to Metal Framing

Type recommended by gypsum board manufacturer.

##### 2.1.6.2 Adhesive for Laminating

For laminating two-ply gypsum board systems, provide adhesive recommended by gypsum board manufacturer.

#### 2.1.7 Shaftwall Liner Panel

ASTM C 442/C 442M. Shaftwall liner panel shall conform to UL Fire Resist Dir for the Design Number(s) indicated. Liner Panel shall be specifically manufactured for cavity shaftwall system, with water-resistant paper faces, bevel edges, single lengths to fit required conditions, 1" thick, by 24" wide.

#### 2.1.8 Accessories

ASTM C 1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

#### 2.1.9 Water

Clean, fresh, and potable.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

### 3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board.

### 3.2 APPLICATION OF GYPSUM BOARD

Gypsum board shall be installed in accordance with ASTM C 840, GA 214 and GA 216 and as specified. Edges and ends of gypsum boards shall be cut to obtain neat fitting joints. End joints of adjoining boards shall be staggered, and shall be staggered on opposite sides of wall. Boards shall be applied with moderate contact without forcing in place. Holes for pipes, fixtures or other small openings shall be cut with a tool which will provide a neat fit. Screws shall be driven so that the heads are slightly below the plane of paper face. Fracturing the paper face or damaging the core shall be avoided. Trim shall be installed at external and internal angles formed by the intersecting gypsum board surfaces with other surfaces. Corner beads shall be installed to vertical and horizontal corners in accordance with manufacturer's published instructions. Boards of maximum practical length shall be used so that an absolute minimum number of end joints occur. Gypsum board partitions in rooms with ceiling heights less than 10 feet shall have full height boards installed vertically with no end joints in the gypsum installation. Gypsum board shall not be secured to top runners of walls that terminate at the roof deck.

#### 3.2.1 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C 840, System XIII or GA 216, unless indicated otherwise. Control joints between studs in fire-rated construction shall be filled with firesafing insulation to match the fire-rating of construction. A control joint or intermediate blocking shall be installed where ceiling framing members change direction.

##### 3.2.1.1 Interior Ceilings with Perimeter Relief

Control joints shall be installed so that linear dimensions between control joints shall not exceed 50 feet in either direction nor more than 2500 square feet.

##### 3.2.1.2 Interior Ceilings without Perimeter Relief

Control joints shall be installed so that linear dimensions between control joints shall not exceed 30 feet in either direction nor more than 900 square feet.

### 3.3 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C 840, GA 214 and GA 216. Plenum areas above ceilings shall be finished to Level 1 in accordance with GA 214. Walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting shall be finished to Level 3 in accordance with GA 214. Walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings shall be

finished to Level 4 in accordance with GA 214. Unless otherwise specified, all gypsum board walls, partitions and ceilings shall be finished to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only.

### 3.3.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

### 3.4 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board as specified in Section 07900a "Joint Sealing." Apply material with exposed surface flush with gypsum board or cementitious backer units.

#### 3.4.1 Sealing for Glass Mat

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat.

### 3.5 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resist Dir for the Design Number(s) indicated. Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements. Penetrations through rated partitions and ceilings shall be sealed tight in accordance with tested systems. Fire ratings shall be as indicated.

### 3.6 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finish as specified.

### 3.7 SHAFT WALL FRAMING

The shaft wall system shall be installed in accordance with the system manufacturer's published instructions. Bucks, anchors, blocking and other items placed in or behind shaft wall framing shall be coordinated with electrical and mechanical work. Fireproofing materials which are damaged or removed during shaft wall construction shall be patched or replaced.

-- End of Section --

## SECTION 09310A

## CERAMIC TILE

11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.1A	(1992) Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar
ANSI A108.1B	(1992) Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar
ANSI A108.5	(1992) Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar
ANSI A108.10	(1992) Installation of Grout in Tilework
ANSI A118.1	(1992) Dry-Set Portland Cement Mortar
ANSI A118.4	(1992) Latex-Portland Cement Mortar
ANSI A118.6	(1992) Ceramic Tile Grouts
ANSI A137.1	(1988) Ceramic Tile

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 241	(1997) Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C 373	(1988; R 1994) Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
ASTM C 482	(1981; R 1996) Bond Strength of Ceramic Tile to Portland Cement
ASTM C 501	(1984; R 1996) Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
ASTM C 648	(1998) Breaking Strength of Ceramic Tile
ASTM C 1026	(1987; R 1996) Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling

ASTM C 1027 (1999) Determining Visible Abrasion Resistance of Glazed Ceramic Tile

ASTM C 1028 (1996) Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

## MARBLE INSTITUTE OF AMERICA (MIA)

MIA Design Manual (1991) Design Manual IV Dimensional Stone

## TILE COUNCIL OF AMERICA (TCA)

TCA Hdbk (1997) Handbook for Ceramic Tile Installation

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191 Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Tile; G  
Mortar and Grout; G

Manufacturer's catalog data and preprinted installation and cleaning instructions.

## SD-04 Samples

Tile; G  
Marble Thresholds; G

Samples of sufficient size to show color range, pattern, type and joints.

## SD-07 Certificates

Tile  
Mortar and Grout

Certificates indicating conformance with specified requirements. A master grade certificate shall be furnished for tile.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact.

Materials shall be kept dry, protected from weather, and stored under cover in accordance with manufacturer's instructions.

#### 1.4 ENVIRONMENTAL REQUIREMENTS

Ceramic tile work shall not be performed unless the substrate and ambient temperature is at least 50 degrees F and rising. Temperature shall be maintained above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used they shall be vented to the outside to avoid carbon dioxide damage to new tilework.

#### 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

### PART 2 PRODUCTS

#### 2.1 TILE

Tile shall be standard grade conforming to ANSI A137.1. Containers shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate. Tile shall be impact resistant with a minimum breaking strength for wall tile of 90 lbs and 250 lbs for floor tile in accordance with ASTM C 648. Tile for cold climate projects shall be rated frost resistant by the manufacturer as determined by ASTM C 1026. Water absorption shall be 0.50 maximum percent in accordance with ASTM C 373.

Floor tile shall have a minimum coefficient of friction of 0.60 wet and dry in accordance with ASTM C 1028. Floor tile shall be Class IV-Heavy Traffic, durability classification as rated by the manufacturer when tested in accordance with ASTM C 1027 for abrasion resistance as related to foot traffic.

##### 2.1.1 Porcelain Tile

Porcelain tile and trim shall be unglazed with the color extending uniformly through the body of the tile. Tile size shall be nominal 12 by 12 inches by 5/16 inch thick. Porcelain wall base shall be 4 inches by 12 inches by 5/16 inches thick. Tile shall meet or exceed the following criteria: Abrasive wear in accordance with ASTM C 501 and bonding strength in accordance with ASTM C 482. Tile shall comply with 36 CFR 1191 for coefficient of friction for interior floors. Color shall be as indicated.

##### 2.1.2 Glazed Wall Tile

Glazed wall tile and trim shall be cushion edged with bright glaze. Tile shall be 4-1/4 x 4-1/4 inches. Color shall be as indicated.

#### 2.2 WATER

Water shall be potable.

#### 2.3 MORTAR AND GROUT

Mortar and grout shall conform to the following:

##### 2.3.1 Dry-Set Portland Cement Mortar

ANSI A118.1.

### 2.3.2 Latex-Portland Cement Mortar

ANSI A118.4.

### 2.3.3 Ceramic Tile Grout

ANSI A118.6; dry-set grout or latex-portland cement grout.

## 2.4 MARBLE THRESHOLDS

Marble thresholds shall be of size required by drawings or conditions. Marble shall be Group A as classified by MIA Design Manual. Marble shall have a fine sand-rubbed finish and shall be gray in color as approved by the Contracting Officer. Marble abrasion shall be not less than 12.0 when tested in accordance with ASTM C 241.

## PART 3 EXECUTION

### 3.1 PREPARATORY WORK AND WORKMANSHIP

Surface to receive tile shall be inspected and shall conform to the requirements of ANSI A108.1A or ANSI A108.1B for surface conditions for the type setting bed specified and for workmanship. Variations of surface to be tiled shall fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Latex portland cement mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Floor tile installation shall not be started in spaces requiring wall tile until after wall tile has been installed. Tile in colors and patterns indicated shall be applied in the area shown on the drawings. Tile shall be installed with the respective surfaces in true even planes to the elevations and grades shown. Special shapes shall be provided as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Tile bases and coves shall be solidly backed with mortar.

### 3.3 INSTALLATION OF WALL TILE AND BASE TILE

Wall tile shall be installed in accordance with the TCA Hdbk, method W243-02.

#### 3.3.1 Dry-Set Mortar and Latex-Portland Cement Mortar

Dry-set or Latex-portland cement shall be used to install tile in accordance with ANSI A108.5. Latex portland cement shall be used when installing porcelain ceramic tile.

### 3.4 INSTALLATION OF FLOOR TILE

Floor tile shall be installed in accordance with TCA Hdbk, method F113-02.

Manufacturer shall provide the recommended mortar and grout products for OSC with Method F113-02 for above grade structural floors.

#### 3.4.1 Latex-Portland Cement

Latex-portland cement mortar shall be used to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI A108.5.

Latex portland cement shall be used when installing porcelain ceramic tile.

#### 3.4.2 Ceramic Tile Grout

Ceramic Tile grout shall be prepared and installed in accordance with ANSI A108.10.

### 3.5 INSTALLATION OF MARBLE THRESHOLDS

Thresholds shall be installed where indicated in a manner similar to that of the ceramic tile floor. Thresholds shall be the full width of the opening. Head joints at ends shall not exceed 1/4 inch in width and shall be grouted full as specified for ceramic tile.

### 3.6 EXPANSION/CONTROL JOINTS

Joints shall be formed as indicated and sealed as specified in Section 07900 JOINT SEALING.

#### 3.6.1 Walls

Expansion/control joints shall be provided at control joints in backing material. Wherever backing material changes, an expansion joint shall be installed to separate the different materials.

#### 3.6.2 Floors

Expansion/control joints shall be provided over construction joints, control joints, and expansion joints in concrete slabs. Expansion/control joints shall be provided where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 24 to 36 feet each way in large interior floor areas.

### 3.7 CLEANING AND PROTECTING

Upon completion, tile surfaces shall be thoroughly cleaned in accordance with manufacturer's approved cleaning instructions. Acid shall not be used for cleaning glazed tile. Floor tile with factory mixed grout shall be cleaned in accordance with instructions of the grout manufacturer. After the grout has set, tile wall surfaces shall be given a protective coat of a noncorrosive soap or other approved method of protection. Tiled floor areas shall be covered with building paper before foot traffic is permitted over the finished tile floors. Board walkways shall be laid on tiled floors that are to be continuously used as passageways by workmen. Damaged or defective tiles shall be replaced.

-- End of Section --

## SECTION 09390

SYNTHETIC FINISH SYSTEM (ACRYLIC TEXTURED FINISH SYSTEM)  
05/01

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Synthetic Finish System; G, AE

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials.

## Application

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats.

## SD-04 Samples

Synthetic Finish System; G

A complete synthetic finish system applied to a panel of the same material as that on which the coating will be applied in the work and for each color indicated. The sample panels will be used for quality control in applying the system.

## 1.2 QUALITY ASSURANCE

## 1.2.1 Single Source Responsibility

Obtain synthetic finish system (SFS) products from a single manufacturer.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack cement board flat to prevent sagging. Handle exterior cement panel to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

## 1.4 PROJECT CONDITIONS

### 1.4.1 Interior Applications

In cold weather and during exterior cement panel installation, temperatures within the building shall be maintained within the range of 45 degrees to 100 degrees F. Adequate ventilation shall be provided to carry off excess moisture.

### 1.4.2 Framing

Framing to receive exterior cement panel shall be structurally sound, free from bow, and in general compliance with local building code requirements. Damaged and excessively bowed framing shall be replaced or repaired before installation of cement panel. Framing shall be designed not to exceed L/240 for the synthetic finish system.

### 1.4.3 Installation Practices

Exterior cement panel should be cut to size with a carbide-tipped knife and a straight edge. A power saw should be used only if it is equipped with a dust collection device and NIOSH-approved dust mask is worn.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Cement Board

Exterior cement panel, 1/2 inch thickness, 48 inch width by 8 foot length.

#### 2.1.2 Joint Reinforcement

Tape, 4 inches by 150 feet, as recommended by the panel manufacturer.

#### 2.1.3 Fasteners

1-5/8 inch steel screws, water head, special corrosion resistant coating as recommended by the panel manufacturer.

#### 2.1.4 Basecoat for Synthetic Finish System

Exterior basecoat, exterior ready-mixed basecoat, or exterior basecoat-fiber-reinforced, gray, ready-to-mix portland cement mortar containing dry latex polymers.

#### 2.1.5 Finish Coat for Synthetic Finish System

Exterior textured finish, ready-mixed acrylic coating, (fine). Color shall be as indicated.

### 2.2 MANUFACTURER

The acrylic textured finish system as manufactured by United States Gypsum or equal complies with this specification. Durock exterior cement board as manufactured by United States Gypsum or equal complies with this specification.

### PART 3 EXECUTION

#### 3.1 CEILINGS

##### 3.1.1 Framing

Framing members shall be spaced maximum 16 inches o.c. Framing shall be capable of supporting the total ceiling system dead load, including insulation, bonding materials and cement board, with deflection not exceeding L/360 of the span.

##### 3.1.2 Panel Application

Apply 1/2 inch exterior cement panel to framing with long dimension across framing. Center end or edge joints on framing and stagger joints in adjacent rows. Fit ends and edges closely, but not forced together. Fasten boards to framing with 1-5/8 inch metal screws spaced 6 inches o.c. with perimeter fasteners at least 3/8 inch and less than 5/8 inch from ends and edges. If necessary, provide additional blocking to permit proper attachment. Edges or ends parallel to framing shall be continuously supported.

#### 3.2 JOINT TREATMENT APPLICATION

Prefill joints with exterior basecoat and then immediately embed 4 inch tape and level the joints. As an alternative, apply exterior tape over joint and then apply exterior basecoat, forcing it through tape to completely fill and level joints. This may require several passes.

#### 3.3 SYNTHETIC FINISH SYSTEM

##### 3.3.1 Basecoat

Apply a 1/16 inch minimum thick, uniform layer of exterior basecoat or exterior ready-mixed basecoat over the entire surface after joints and trim have cured a minimum of 4 hours. Allow exterior ready-mixed basecoat to dry 24 hours. Apply material by tightly scratching in an initial coat, then doubling up the 1/16 inch thickness. Do not add sand or other additives. Use exterior basecoat-fiber-reinforced to fill voids and depressions up to 1/4 inch. Do not apply material greater than 1/8 inch thick in a single application. Leave surface smooth and flat. Under rapid drying conditions, dampen surface as necessary to improve workability. Allow basecoat to cure 24 hours before application of synthetic finish system.

##### 3.3.2 Finish Coat

Trowel-apply exterior textured finish in a 1/16 inch minimum thick, uniform layer over all basecoated surfaces. Do not add sand or other additives to create heavier textures (material is not designed for texture heavier than 3/16 inch). If necessary, adjust consistency and working properties by adding up to 8 oz. clean water per 67.5 lb. pail of finish material. Add the same amount of water to all subsequent pails to ensure color uniformity. Mix well for uniform consistency. Provide fine texture using plastic or wood floats as required.

#### 3.4 CLEANING

Remove temporary coverings used to protect other work. Remove spillage

promptly from door frames, windows and other adjoining work. Repair surfaces which have been damaged by finish work.

### 3.5 PROTECTION

Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures synthetic finish system work being without damage or deterioration at time of substantial completion.

-- End of Section --

## SECTION 09490

SPECIAL COATING  
05/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84 (1996) Surface Burning Characteristics for Building Materials

ASTM E 96 (1995) Water Vapor Transmission of Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Special Coating; G, AE

Submit manufacturer's technical information including installation instructions, product description, and product test data conforming to the test performances required herein. Test data may be submitted in printed form from the manufacturer's standard printed material.

Mixing and Thinning; G, AE

Application; G, AE

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning, and application instructions, minimum and maximum application temperature, and curing and drying times between coats.

## SD-04 Samples

Special Coating; G, AE

Prior to beginning work, Contractor shall make and submit three (3) 3 inch by 10 inch samples of the selected colors and textures for

review. Provide for each sample a listing of materials and the application for each coat of material. In addition to the above, Contractor shall install on the jobsite one sample of each Textured Acrylic Coating finish on each different typical jobsite substrate.

Each sample shall be installed over an area of not less than 20 square feet. Contractor shall also create or cause to be created temporary or permanent lighting which accurately reproduces finished project lighting conditions for the purpose of viewing above samples. Work on the balance of the areas to be coated shall commence after Contractor has received written approval of the installed jobsite samples from Architect or Owner.

### 1.3 QUALITY ASSURANCE

#### 1.3.1 Single Source Responsibility

Provide primers and other substrate preparation materials which are produced or are specifically recommended by the same manufacturer as the finish materials to insure compatibility of the system. Use thinners approved by the coating manufacturer, and use only within recommended limits.

#### 1.3.2 Qualified Applicator

All bidding applicators must have been factory trained and qualified to apply materials prior to submitting bid. Applicator shall submit a photocopy of factory certificate as proof of factory qualification with bid.

#### 1.3.3 Skilled Workmanship

All work shall be done by skilled mechanics in accordance with the best standard practice in the industry. Work shall be uniform in appearance, free of visual defects, and complete.

#### 1.3.4 Coordination of Work

Review other sections of these specifications in which prime paints, raw substrates, or other substances might be present to insure compatibility of total coatings systems. Upon request from other trades, furnish information or characteristics of coating materials provided for use to insure compatible substrate materials and finishes are used.

### 1.4 DELIVERY AND STORAGE

#### 1.4.1 Deliver Materials

Deliver materials to job sit in the original, new and unopened packages and containers bearing manufacturer's name and label, and following information: Name or title of materials, manufacturer's stock and/or batch number date of manufacture, contents of containers including color name and number.

#### 1.4.2 Store Materials

Store materials not in active use in tightly covered containers. Maintain containers in a clean condition, free from foreign materials and residue. Protect from freezing and maintain temperatures below 100 degrees F. Keep materials stored in an orderly and organized manner to reduce the risk of error. Do not stack materials more than three containers high. Protect

from fire hazards.

## 1.5 JOB CONDITIONS

### 1.5.1 Apply Materials

Apply materials only when surface temperature is between 60 and 100 degrees F. If dry conditions cause rapid drying of the materials before proper finishes can be completed, eliminate breezes, fans or other air movements which contribute to the problem, and, if necessary, dampen the substrate with finely misted water just prior to application.

### 1.5.2 Protect Finishes

Protect finishes from casual impact for a period of forty-eight hours after installation. Protect from heavy traffic for a period of at least three days. Protect all surfaces and adjacent areas not intended to be coated and clean immediately any spillage, droppings, or other extraneous contact of the materials with other surfaces.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Special coating shall be a textured acrylic coating. Textured acrylic coating materials shall have the following minimum performance characteristics when finished and fully cured (28 days under nominal conditions):

#### STANDARDIZED TESTS:

Barcoll Hardness Index	35.0 or greater
ASTM E 84 Flame Spread	8.5 or less ASTM E 84
Smoke Contribution	7.0 or less
Federal Aviation Agency Vertical Burn Test #FAR 25.853 (b)	0.1 second or less
Water Vapor Permeability ASTM E 96, B	27.5 English Perms or greater
UPITT (LC50) for thermal decomposition)	150 grams or greater

#### SOLVENT RESISTANCE: (1 hour soak)

Water	temporary slight softening*
Detergent	no change
Ethanol	no change
Naphtha	no change
Ammonium Hydroxide	temporary slight softening*
Ethylene Glycol	no change
Bleach (household)	temporary slight softening*
Mineral spirits	no change

\*Original hardness regained after drying.

#### STAIN RESISTANCE: (10 hour soak and wash with 409 Cleaner or bleach, and water)

Water	no stain visible
Blood	no stain visible
Urine	no stain visible
Coffee	no stain visible

Tea	no stain visible
Blueberry	no stain visible
Mustard	no stain visible

MILDEW RESISTANCE No visible mildew after incubation for ninety days in 95 degrees F and 90% relative humidity under high contamination conditions.

COLOR: All pigments shall be: free of heavy metals, color fast, fade resistant, and bleach resistant. Provide at least EIGHTY factory colors and factory custom color service.

MINIMUM FACTORY WARRANTY REQUIREMENTS:

Material Warranty-coating integrity 10 years  
 Mold & Mildew Warranty 10 years  
 Product must have been in commercial use for a time period that meets or exceeds factory stated warranty period.

## 2.2 MANUFACTURER

Duroplex textured acrylic coating as manufactured by Triarch Industries, Inc. or equal complies with this specification. Tex-Cote by Textured Coatings of America is an acceptable equal. Provide coating by Triarch Industries' Textured Coatings of America or approved equal.

## PART 3 EXECUTION

### 3.1 GENERAL

Perform preparation and cleaning procedures in accordance with manufacturer's recommendations and as herein specified, for each particular substrate condition. Remove hardware, hardware accessories, machines surfaces, plates, lighting fixtures, and similar items in place and not to be finish coated, or provide masking or other protection prior to surface coating operations. Following completion of coating of each space or area, reinstall removed items. Clean surfaces to be coated before applying any materials. Remove oils and grease prior to mechanical cleaning. Program cleaning and coating so that contaminants for cleaning process will not fall into wet or newly coated surfaces.

### 3.2 SURFACE PREPARATION

#### 3.2.1 Gypsum Wallboard

Prepare to industry acceptable standard for hanging vinyl wall covering. Remove excess gypsum compound dust. Do not prime or seal the wallboard except as specifically recommended by coating manufacturer. Dampen surface slightly with a light spray mist of water just prior to application of acrylic wall coating materials.

### 3.3 MATERIALS PREPARATION

Stir materials before application with a power drill and a drywall compound paddle. Stir at approximately 350 RPM for three minutes while removing material from all sides and bottom of the container. Stir only as much

material as will be used in a four hour period or re-stir material left sitting in excess of four hours. Retain lid on containers until the material is in actual use. If hardened material accumulates on the sides of the container, remove the material to a clean container before use. Thinning may be done with small amount of clean water. See manufacturer's written instructions for thinning information.

#### 3.4 APPLICATION

Apply coating materials in accordance with the manufacturer's instructions and recommendations as required to achieve the appearance of the approved samples and performance as specified herein. Coating materials shall be used as a system which may include primers or undercoatings as required by the manufacturer's installation directions. Final dry film thickness shall be a minimum average of 20 mils. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces.

#### 3.5 PRIMER

For finishes which require primer, apply acrylic coating manufacturer furnished primer with a 1/4 to 3/8 inch nap paint roller at a coverage rate of 240 square feet per gallon. Allow to cure until firmly set (normally 1 to 2 hours).

#### 3.6 UNDERCOAT

For finishes which require undercoat, apply factory supplied undercoat at a rate of 250 square feet per 60 pound net pail. Apply with a texture sprayer to achieve visible coverage. Wet film material should be approximately 20 mils thick. Apply undercoat to a uniform level finish without holidays or runs.

#### 3.7 FINISH

Apply finish coat(s) in accordance with manufacturer's instructions and training until all finishes match quality samples previously approved by Architect.

#### 3.8 CLEANUP AND PROTECTION

During progress of work, remove from site discarded coating materials, rubbish, cans, and rags at the end of each work day. Protect work of other trades, whether to be coated or not, against damage by coating work. Correct any damage by cleaning, repairing or replacing, and refinishing, as acceptable to Architect. Provide signs, barricades, etc. as required to protect new coating work from damage by others. After completion of work of all other trades, remove all protection materials (including other trades if provided by them) and clean/touch up as necessary to restore coating work to new and unblemished condition.

-- End of Section --

## SECTION 09510A

ACOUSTICAL CEILINGS  
10/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 635	(2000) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1996) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E 580	(2000) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint
ASTM E 1264	(1998) Standard Classification for Acoustical Ceiling Products
ASTM E 1414	(2000) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum

## U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04	(1998) Seismic Design for Buildings
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Approved Detail Drawings; G, AE

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

## SD-04 Samples

#### Acoustical Units; G

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

#### SD-07 Certificates

#### Acoustical Units

Certificate attesting that the mineral based acoustical units furnished for the project contain recycled material and showing an estimated percent of such material.

### 1.3 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The location and extent of acoustical treatment shall be as shown on the approved detail drawings. Reclamation of mineral fiber acoustical ceiling panels to be removed from the job site shall be in accordance with paragraph RECLAMATION PROCEDURES.

### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

### 1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

### 1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided. Standard performance guarantee or warranty shall contain an agreement to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

### 1.8 EXTRA MATERIALS

Spare tiles of each color shall be furnished at the rate of 5 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those

installed.

## PART 2 PRODUCTS

### 2.1 ACOUSTICAL UNITS

Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

#### 2.1.1 Units for Exposed-Grid System A, as Indicated on Drawings

Type: III (mineral fiber with painted finish). Type III acoustical units shall have a minimum recycled material content of 40 percent.

Minimum NRC: 0.55 when tested on mounting No. E-400

Nominal size: 24 by 24 inches.

Edge detail: Angled tegular.

Finish: Factory-applied standard finish.

Minimum LR coefficient: .84.

Minimum CAC: 35.

### 2.2 SUSPENSION SYSTEM

Suspension system shall be standard exposed-grid standard width flange, and shall conform to ASTM C 635 for heavy-duty systems. Surfaces exposed to view shall be aluminum with a factory-applied white color baked-enamel finish. Wall molding shall have a flange of not less than 15/16 inch. Inside and outside corner caps and Mitered corners shall be provided. Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown.

The suspension system shall have a maximum deflection of 1/360 of span length. Seismic details and antiterrorism/force protection shall conform to the guidance in TI 809-04 and ASTM E 580. Suspension system supporting assemblies in excess of 31 pounds shall be mounted such that they resist forces of minimum 0.5 times the component weight in any direction and minimum 1.5 times the component weight in the downward direction. This criteria is in addition to other criteria such as seismic standards.

### 2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 300 pound ultimate vertical load without failure of supporting material or attachment and shall not be lighter than 12 gauge.

### 2.4 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

### 2.5 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components

shall be as indicated on drawings.

## 2.6 CEILING ATTENUATION CLASS AND TEST

Ceiling attenuation class (CAC) range of acoustical units, when required, shall be determined in accordance with ASTM E 1414. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project. System shall be tested with all acoustical units installed.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a subsuspension system shall be installed, so that all hanger wires will be plumb. All main runners shall be supported within 6 inches of walls by hangers. Support of main runners from edge angles is not acceptable.

#### 3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

##### 3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

##### 3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, countersplaying, or other acceptable means. Splaying of wires shall require wires to be of equal angle from the vertical 90 degrees to negate horizontal forces on the suspension system.

##### 3.1.1.3 Antiterrorism/Force Protection Restraint

Provide antiterrorism/force protection restraint for the suspension system in accordance with ASTM E 580. Restraints for antiterrorism/force protection shall be based on severe seismic disturbance.

#### 3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 3 inches from ends of each length and not more than 16 inches on centers between end fastenings.

#### 3.1.3 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips. No unit shall be less than 6 inches in width. Where unit would be less than 6 inches in width, a 24 inch by 48 inch unit shall be cut to facilitate an oversize panel.

### 3.2 CEILING ACCESS PANELS

Ceiling access panels shall be located directly under the items which require access.

### 3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

### 3.4 RECLAMATION PROCEDURES

Ceiling tile, designated for recycling by the Contracting Officer, shall be neatly stacked on 4 by 4 foot pallets not higher than 4 foot. Panels shall be completely dry. Pallets shall then be shrink wrapped and symmetrically stacked on top of each other without falling over. Disposal shall be in accordance with Section 01572A CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT.

-- End of Section --

SECTION 09650A  
RESILIENT FLOORING  
07/96

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2240	(199e1) Rubber Property - Durometer Hardness
ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1999) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1997) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1999) Vinyl Composition Floor Tile
ASTM F 1344	(1996) Rubber Floor Tile

1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Resilient Flooring and Accessories

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-04 Samples

Flooring; G

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 2-1/2 x 4 inches.

#### SD-06 Test Reports

##### Moisture Test

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

#### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 70 degrees F for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

#### 1.5 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 70 degrees F and below 100 degrees F for 2 days before application, during application and 2 days after application. A minimum temperature of 55 degrees F shall be maintained thereafter.

#### 1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

#### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

#### 1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 5 tiles for each 1000 tiles installed. Extra materials shall be from the same lot as those installed. Extra base material composed of 20 linear feet of each color shall be furnished.

### PART 2 PRODUCTS

#### 2.1 VINYL-COMPOSITION TILE TYPE, AS INDICATED ON DRAWINGS

Vinyl-composition tile shall conform to ASTM F 1066, Class 2, (through pattern tile), Composition 1, asbestos-free, and shall be 12 inches square and 1/8 inch thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

#### 2.2 RUBBER FLOORING TYPE, AS INDICATED ON DRAWINGS

### 2.2.1 Rubber Tile

Rubber tile shall conform to ASTM F 1344 Class 1 homogeneous construction, Type B (through mottled) 24 inches square. Surface shall be raised, round studs with chamfered edges. Stud profile shall be low. Overall thickness shall be 1/8 inch thick.

### 2.3 STAIR TREADS, RISERS, AND STRINGERS

Treads, risers, and stringers shall conform to composition rubber compounded from a mixture of synthetic and reclaimed rubber. Overall thickness at treads shall be not less than 1/8 inch. Durometer hardness shall be 90, plus or minus 5, when tested in accordance with ASTM D 2240. Design shall be either a one piece nosing/tread/riser. Installation shall include stringer angles on both the wall and banister sides, and landing trim. Surface of treads shall be raised and round.

### 2.4 RESILIENT BASE

Base shall be manufacturers standard rubber, straight style (installed with carpet) and coved style (installed with resilient flooring). Base shall be 4 inches high and a minimum 1/8 inch thick. Preformed outside corners shall be furnished.

### 2.5 TRANSITION STRIP

A rubber transition strip tapered to meet abutting material shall be provided.

### 2.6 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

### 2.7 POLISH

Polish shall conform to ASTM D 4078.

### 2.8 CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07900 JOINT SEALING.

### 2.9 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be as indicated on drawings.

## PART 3 EXECUTION

### 3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

### 3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

### 3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

### 3.4 INSTALLATION OF VINYL-COMPOSITION TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

### 3.5 INSTALLATION OF RUBBER FLOORING

Rubber flooring shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge pieces shall be less than one-half the field size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edges shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

### 3.6 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk.

### 3.7 INSTALLATION OF TREADS AND RISERS

Stair treads and risers shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Treads and risers shall cover the full width of the stairs. Stairs wider than manufacturer's standard lengths shall have equal length pieces butted together to cover the treads.

### 3.8 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus

adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and, except for raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile, given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine. Raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile shall be cleaned and maintained as recommended by the manufacturer.

### 3.9 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

-- End of Section --

## SECTION 09685N

## CARPET TILE

08/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC 16	(1993) Colorfastness to Light
AATCC 107	(1997) Colorfastness to Water
AATCC 129	(1996) Colorfastness to Ozone in the Atmosphere under High Humidities
AATCC 134	(1996; R 1996) Electrostatic Propensity of Carpets
AATCC 165	(1993) Colorfastness to Crocking: Carpets - AATCC Crockmeter Method

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 418	(1993) Testing Pile Yarn Floor Covering Construction
ASTM D 1335	(1998) Tuft Bind o f Pile Yarn Floor Coverings
ASTM D 3936	(1997) Resistance to Delamination of the Secondary Backing of Pile Yarn Floor Covering
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

## CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1994) Installation of Commercial Texture Floorcovering Materials
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## INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2551	(1981) Man-made Textile Floor Coverings - Determination of Dimensional Changes Due to the Effect of Varied Water and Heat Conditions (AACHEN Test)
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99 (1996) Health Care Facilities

NFPA 101 (1997) Life Safety Code

## 1.2 GENERAL DESCRIPTION

Work of this section requires Contractor to provide carpet tile from a single source and dye lot. Part of the carpet tile to be field installed. The remaining carpet tile to be shipped to the raised flooring manufacturer for installation to raised access floor panels.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

### SD-02 Shop Drawings

Carpet tile installation

Submit drawings that include area to be carpeted; moldings and edge strips and location; details of special treatments, such as ducts and trench headers and location.

### SD-04 Samples

Carpet tile; G

Molding; G

### SD-06 Test Reports

Flammability

Static control

CRI Green Label Requirements for Indoor Air Quality Test Criteria

ADA requirements

The reports shall be dated within two years of submittal for approval.

### SD-07 Certificates

Installation experience

Carpet tile

Submit certificates attesting that the carpet tile meets the requirements of the paragraphs entitled "Flammability," "ADA Requirements," and "Indoor Air Quality."

### SD-08 Manufacturer's Instructions

Carpet tile installation

Submit the carpet manufacturer's printed installation instructions. Include procedures for installation covering preparation of the

substrate, seaming techniques, and recommended adhesives and tapes where applicable.

#### SD-10 Operation and Maintenance Data

Carpet tile, Data Package 1

Submit data package in accordance with Section 01781, "Operation and Maintenance Data." Submit copies of the manufacturer's maintenance manual.

### 1.4 INSTALLATION REQUIREMENTS

#### 1.4.1 Experience

All work shall be done by installation firms specializing in commercial carpet installation. The firm shall be a member of the Floor Covering Installation Contractor's Association (FCICA) or certified by the Floor Covering Installation Board (FCIB).

#### 1.4.2 Certificate

Submit certificate from the Contractor attesting that the installation supervisors for carpet tile installation on regular concrete slab floor surface and raised access floor panel surface and has had a minimum of 5 years experience in this type of work and will provide qualified, experienced installers to perform work. Include a list of previous jobs giving name, location, dollar value, and date, setting forth supervisor's installation experience. Access floor panel requirements shall be in accordance with Section 10270A RAISED ACCESS FLOOR (RAF) SYSTEM.

### 1.5 DELIVERY AND STORAGE

Deliver carpet tile to the site and raised access floor manufacturer as required in manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, and related information. Attach register number or stencil on carton. Store in a safe, dry, clean, and well ventilated area. Do not open containers until needed for installation unless verifying inspection is required. Do not stock more than eight cartons high.

### 1.6 SAFETY

Carpet adhesives may contain toxic volatile components. Follow ventilation, personal protection, and other safety precautions as recommended by the manufacturer of the adhesive.

### 1.7 REGULATORY REQUIREMENTS

#### 1.7.1 Indoor Air Quality

Carpet shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label. Carpet type bearing the label will indicate that the carpet has been tested and meets the criteria of the CRI Green Label Requirements for Indoor Air Quality Test Criteria.

#### 1.7.2 ADA Requirements

Carpet shall meet the ADA requirements as follows:

If carpet tiles are used on a ground or floor surface, then it shall be securely attached; have a firm cushion, pad, or backing, or no cushion or pad; and have a level loop, textured loop, level cut pile, or level cut/uncut pile texture. The maximum thickness shall be 1/2 inches. Exposed edges of carpet shall be fastened to floor surfaces and have trim along the entire length of the exposed edge.

## PART 2 PRODUCTS

### 2.1 PHYSICAL REQUIREMENTS

Provide carpet tile from manufacturer's standard stock. Carpet shall be first quality; and free of visual blemishes, streaks, poorly dyed areas, and other physical and manufacturing defects. Use nontoxic carpet materials and treatments, reasonably nonallergenic, and free of other recognized health hazards. Provide carpet tile of tufted, woven, or fusion bonded construction with a secondary backing of vinyl or prereacted polyurethane hardback, or a woven polypropylene fabric with a thermoplastic mixture of ethylene/vinyl acetate polymer and a hydrocarbon resin (hot melt). Carpet tile shall be of the modular type, identical in size, precision die cut for complete interchangeability. Sides shall be straight and the corners square. Tufts shall be firmly secured at the edges as in the other areas of the carpet tile. Carpet tile must lay flat on a flat surface without curling, warping, buckling, cupping, or doming and without any lumpiness, unevenness, or differences in thickness in individual tiles or from tile-to-tile. Provide carpet tile that does not stretch or shift position in use when installed according to the carpet tile manufacturer's instructions. Use nontoxic carpet tile materials and treatment, free from other recognized health hazards, and conforming to the following:

- a. Surface Texture: Tufted Patterned Loop.
- b. Pile Yarn Type: Level-loop.
- c. Pile Fiber: Commercial branded 6.6 Nylon continuous filament.
- d. Tuft Density: Minimum 113.1 Tufts/sq. in.
- e. Pile Density: Minimum 7.9 oz/cuyd.
- f. Width: 23 5/8 inch by 23 5/8 inch plus or minus 1/16 inch.
- g. Gage: 1/13 per one inch minimum in accordance with ASTM D 418ASTM D 418.
- h. Dye method: 65 percent solution dyed / 35 percent yarn dyed..
- i. Soil/stain protection required.
- j. Pattern and Color: As indicated in drawings

#### 2.1.1 Surface Texture

##### 2.1.1.1 Loop Pile

Provide either single-level uncut pile or textured uncut pile creating an overall nondirectional surface. Maximum differential finished pile heights

(high and low pile loops) of textured pile is 0.125 inch.

#### 2.1.2 Pile Yarn

Do not use reclaimed yarn fibers from any woven, tufted, knitted, or felted products. Do not use undrawn fiber in spun yarn. Provide spun yarn of at least two ply for loop pile carpet tile. Use yarn setting method sufficient to assure permanent texture retention under normal use conditions, cleaning, and shampooing. Use autoclave or continuous heat process to set yarn in cut pile construction; yarns for fusion bonded plush cut pile may be crimp-set. Fiber denier and staple lengths may be subject to normal manufacturing tolerances with the following limitations:

- a. Acceptable denier variance, plus or minus 10 percent, in individual filament denier and plus or minus 3 percent in average denier.

##### 2.1.2.1 Continuous Hollow Filament Nylon

Branded, continuous high bulk or textured carpet fiber with average filament size of 15 denier or coarser modified to provide increased translucence or opacity for soil hiding.

#### 2.1.3 Primary Carpet Backing

Synthetic non-woven customarily used and accepted by the trade for carpet tile. Use a back coating compound of synthetic resin or natural or synthetic latex compound. Use back coating quantity normally used in the supplier's product.

#### 2.1.4 Secondary Backing

Shall be fiberglass reinforced vinyl hardback for fusion bonded carpet tile. Should be prereacted polyurethane hardback, fiberglass reinforced vinyl hardback, or woven polypropylene fabric adhered with ethylene/vinyl acetate polymer and hydrocarbon resin (hot melt) for woven or tufted carpet tile.

##### 2.1.4.1 Vinyl Hardback

A suitably compounded virgin polymer or copolymer of vinyl chloride resin, plasticized with compatible, primary plasticizers only. Virgin polymer is defined as a polymer or copolymer that has not been processed into a finished product prior to use in the hardback. Primary plasticizers are as plasticizers which are individually and totally compatible with the polymers or copolymers of vinyl chloride resin. Use compound that is uniform and free from objectionable odor, and conforming to the following:

- a. Hardback: Average not less than 0.115 inch in total backing thickness.
- b. Weight: Average not less than 125 oz/sqyd.
- c. Compression resistance: Not less than 100 pounds per square inch.
- d. Adherence: No separation of the carpet tile and hardback.
- e. Accelerated weathering: No cracking, stiffness, brittleness, soft or tacky and appreciable change in color, when compared to the unexposed sample, after 100 hours in the weatherometer.

- f. Flexibility at 70 degrees F and at 30 degrees F: No cracking, flaking, crazing, or show any other indication of failure.
- g. Moisture absorbency: Maximum one percent moisture absorbency, after 4 hours submersion in water at 72 degrees F.
- h. Volatile matter: No more than one percent.

#### 2.1.5 Recycled Content

Product recycled content is 34.7 percent and 7 percent post consumer content. Certified by an independent third party, scientific certification systems.

### 2.2 PERFORMANCE REQUIREMENTS

#### 2.2.1 Dimensional Stability

Dimensional stability shall be maintained at +/-, 0.2 percent maximum in according with ISO 2551 (AACHEN Test).

#### 2.2.2 Delamination Strength

Delamination strength for turfed carpet with secondary back shall be a minimum of 25 lb/inch in accordance with ASTM D 3936.

#### 2.2.3 Flexibility

Secondary backing must not crack, flake, craze, or show any other indications of failure when tested as specified below.

##### 2.2.3.1 At 70 Degrees F

Use a 4 by 4 inch specimen. Double the specimen and press flat on itself in any direction. Hold doubled for 5 minutes. Examine for indications of failure while doubled and after pressed flat. Make the examination visually at a distance of one foot.

#### 2.2.4 Colorfastness to Light

AATCC 16. Use the Xenon arc as the light source. Consider colors that are deeper or equivalent in hue to Row 2 of the AATCC Color Transference Chart as dark colors; consider those lighter as light colors. Colors for synthetic yarns shall show a gray scale rating of at least 4 for light shades after the equivalent of two L-4 breaks and at least 4 for dark shades after the equivalent of at least three L-4 breaks. Woolen yarns show a gray scale rating of at least 4 for light shades after the equivalent of one L-4 break and at least 4 for dark shades after the equivalent of two L-4 breaks. Base classification on the AATCC Blue Wool Lightfastness Standards L-2 to L-9. Test all colors specified. If the Xenon Arc Fadeometer has a built-in continuous monitor and control device made by the manufacturer, the blue wool standards referenced in AATCC 16 need not be used to judge the L-4 breaks, providing the manufacturer's instructions are followed.

#### 2.2.5 Dry and Wet Crocking, Color Fastness to Water and to Ozone

AATCC 165 AATCC 107 AATCC 129. All colors specified shall show a minimum

rating of step 4 on the AATCC Color Transference Chart.

#### 2.2.6 Pile Coverage

Sufficient to conceal backing.

#### 2.2.7 Tuft Bind

ASTM D 1335. The minimum tuft bind for loop pile is 10 pounds.

#### 2.2.8 Flammability

In addition to meeting the requirements of CPSC FF170, Class 1 (CRF average at 0.45, all carpet tile shall meet the minimum radiant flux requirements of NFPA 101 when tested in accordance with ASTM E 648. Test carpet tile and hardback together, as they will be installed.

#### 2.2.9 Static Control

AATCC 134. Incorporate a permanent static control system to control static build-up to less than 3.0 kV or lower. Test at 20 percent relative humidity at 70 degrees F.

#### 2.2.10 Electrical Resistance

NFPA 99, Chapter 3. Maximum electrical resistance for carpet tile shall be 20,000 megohms measured between the floor surface and building or applicable ground material, and shall provide a resistance of not less than 150 kilohms when measured from any point on the floor.

### 2.3 MOLDING

Provide floor flange at least 2 inches wide, face shall be a minimum 5/8 inch wide. Heavy-duty vinyl designed for the type of carpet tile being installed. Floor flange at least 2 inches wide. Color: Grey to match wall base.

### 2.4 ADHESIVES

Waterproof, nonflammable, shall be a pressure sensitive releasable adhesive carpet as furnished or recommended by the carpet manufacturer. Use waterproof, nonflammable, and nonstaining seal adhesive as furnished or recommended by the carpet manufacturer. Low emitting volatile organic compound (VOC) adhesive should be used to improve indoor air quality.

## PART 3 EXECUTION

### 3.1 CARPET TILE INSTALLATION

Install carpet tile in accordance with CRI 104 and manufacturer's printed instructions after the work of other trades, including painting, is done. Installed carpet tile must be smooth, uniform, and secure. Install tile with carpet pile lay in same direction in design as indicated on drawings. Fit cutouts, such as door jambs, columns, and ducts, neatly and securely.

#### 3.1.1 Carpet Tile Location

Install carpet tile wall-to-wall in rooms and areas indicated on finish/color schedule in the drawings. Include all material indicated,

specified, or necessary for a completely finished installation. Contractor is responsible for providing carpet of the same dye lot for type indicated, for the required quantities of carpet and must verify all dimensions in the field, raised access manufacturers' requirements, as well as other conditions affecting the work.

### 3.1.2 Extra Carpet Tile

Furnish three cartons of carpet tiles of pattern and color in addition to the quantity required for installation. Furnish extra carpet tile, for replacement use, of same manufacturer, type, and quality as the installed carpet tile; provided in original cartons; and properly marked.

### 3.1.3 Substrate Preparation

Inspect rooms and areas to be carpeted. Before installation, verify that concrete floors comply with requirements on moisture content recommended by adhesive or carpet manufacturer's instructions. Repair holes, cracks, depressions, or rough areas using material recommended by the carpet tile manufacturer. Grind raised areas or ridges smooth and level with surrounding surface. Provide floor free of any foreign materials and swept broom clean. Comply with requirements for conditioning adhesives and minimum floor temperature before, during, and after installation as recommended by the carpet tile and adhesive manufacturer's instructions. However, in no case may floor temperature be less than 60 degrees F for 24 hours prior to, during, and after installation. Do not permit traffic or movement of furniture or equipment in carpeted areas for at least 24 hours after installation. Carpet tile installation constitutes validation by the Contractor that the substrate and conditions in the area meet all requirements for satisfactory installation.

Carpet tile installation on raised flooring panels and installation of raised flooring system constitutes validation by the Contractor that the substrate and field conditions meet all requirements.

### 3.1.4 Accessibility

Installed carpet tiles shall be removable. Ensure that the exposed area is capable of being restored to its original condition by replacing the removed tiles or installing new tiles of the same manufacturer, type, and quality.

Carpet tiles installed on raised access floor panels shall be permanently adhered by raised flooring system manufacturer.

### 3.1.5 Molding

Finish carpet tile edges meeting hard surface flooring with moldings. Install in accordance with manufacturer's instructions.

## 3.2 CLEANING AND PROTECTION

### 3.2.1 Cleaning

After installation, remove all debris, moldings, scraps, and other foreign matter. Remove any soiled spots or adhesive from the face of the carpet tile with the appropriate spot remover. Clip any protruding face yarn with sharp scissors. Vacuum the carpet tile until clean.

### 3.2.2 Protection

Carefully protect installed carpet tile with heavy, reinforced, nonstaining kraft building paper or polyethylene film of an approved quality and thickness. Lap and secure edges of covering widths. Keep covering in repair and replace damaged portions. Remove protective covering when directed by the Contracting Officer.

-- End of Section --

## SECTION 09720A

## WALLCOVERINGS

04/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM F 793	(1993; R 1998) Standard Classification of Wallcovering by Durability Characteristics

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Wallcoverings  
Manufacturer's Instructions

Manufacturer's descriptive data, documentation stating physical characteristics, flame resistance, mildew and germicidal characteristics.

## Installation

Preprinted installation instructions for wallcovering and accessories.

Maintenance  
Clean-Up

Preprinted cleaning and maintenance instructions for wallcovering and accessories.

## SD-04 Samples

## Wallcoverings; G

Three samples of each indicated type, pattern, and color of wallcovering. Samples of wall covering shall be minimum 5 x 7 inches and of sufficient size to show pattern repeat.

## SD-07 Certificates

## Wallcoverings

Manufacturer's statement attesting that the product furnished meets or exceeds specification requirements. The statement must; be dated after the award of the contract, state Contractor's name and address, name the project and location, and list the requirements being certified.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in manufacturers original unopened containers labeled with manufacturers name, pattern, texture, size and related information. Materials shall be stored in accordance with the manufacturer's instructions in a clean dry ventilated area with temperature maintained above 60 degrees F for two days prior to installation.

## 1.4 ENVIRONMENTAL REQUIREMENTS

Areas to receive wallcovering shall be maintained at a temperature above 60 degrees F for 7 days before, during, and 7 days after application.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

## 1.6 EXTRA MATERIALS

Extra material from the same dye lot consisting of 0.5 yards of full-width wallcovering for each 30 linear yards of wallcovering installed shall be provided for maintenance.

## PART 2 PRODUCTS

## 2.1 WALLCOVERINGS

Wallcoverings shall be material designed specifically for the specified use. The wallcovering shall contain a non-mercury based mildewcide. The wallcovering shall be type made without the use of cadmium based stabilizers. Wallcovering shall have a Class A flame spread rating of 0-25 and smoke development rating of 0-50 when tested in accordance with ASTM E 84.

## 2.1.1 Vinyl Wallcovering Type A, as Indicated on Drawings

Vinyl wallcovering shall be a vinyl coated woven or nonwoven fabric with germicidal additives and shall conform to ASTM F 793, Category V Type II, (20 ounces) total weight per square yard and width of 54 inches.

## 2.2 PRIMER AND ADHESIVE

Primer and adhesive shall be of a type recommended by the wallcovering manufacturer and shall contain a non-mercury based mildewcide. Adhesive shall be strippable type.

## 2.3 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be as indicated on drawings.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

Contractor shall inspect all areas and conditions under which wallcoverings are to be installed. Contractor shall notify in writing of any conditions detrimental to the proper and timely completion of the installation. Work will proceed only when conditions have been corrected and accepted by the installer.

#### 3.2 SURFACE PREPARATION

Wallcovering shall not be applied to surfaces that are rough, that contain stains that will bleed through the wallcovering, or that are otherwise unsuitable for proper installation. Cracks and holes shall be filled and rough spots shall be sanded smooth. Surfaces to receive wallcovering shall be thoroughly dry. Plaster surfaces shall age at least 30 days prior to installation of vinyl wallcoverings. Interior surfaces of exterior masonry walls shall be sealed to prevent moisture penetration, then primed with a wallcovering primer in accordance with the manufacturer's instructions. Moisture content of plaster, concrete, and masonry shall be tested with an electric moisture meter and reading shall be not more than 5 percent. Masonry walls shall have flush joints. Concrete and masonry walls shall be coated with a thin coat of joint compound or cement plaster as a substrate preparation. To promote adequate adhesion of wall lining over masonry walls, the walls shall be primed as recommended by the wall lining manufacturer. Surface of walls shall be primed as required by manufacturer's instructions to permit ultimate removal of wallcovering from the wall surface. Primer shall be allowed to completely dry before adhesive application.

#### 3.3 INSTALLATION

##### 3.3.1 Vinyl Wallcovering

Wallcovering shall be installed in accordance with the manufacturer's installation instructions. Glue and adhesive spillage shall be immediately removed from wallcovering face and seams with a remover recommended by the manufacturer. After the installation is complete, the fabric wallcovering shall be vacuumed with a ceiling to floor motion.

#### 3.4 CLEAN-UP

Upon completion of the work, wallcovering shall be left clean and free of dirt or soiling. Surplus materials, rubbish, and debris resulting from the wallcovering installation shall be removed and area shall be left clean.

-- End of Section --

## SECTION 09900

## PAINTS AND COATINGS

## 02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH Limit Values (1991-1992) Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)

ACGIH TLV-DOC Documentation of Threshold Limit Values and Biological Exposure Indices

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 523 (1999) Standard Test Method for Specular Gloss

ASTM D 2092 (1995) Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting

ASTM D 4444 (1998) Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters

## CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.1000 Air Contaminants

## FEDERAL STANDARDS (FED-STD)

FED-STD-313 (Rev. C) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

## MASTER PAINTERS INSTITUTE (MPI)

MPI 2 (2001) Aluminum Heat Resistant Enamel (up to 427 C and 800 F)

MPI 4 (2001) Interior/Exterior Latex Block Filler

MPI 11 (2001) Exterior Latex, Semi-Gloss

MPI 19 (2001) Inorganic Zinc Primer

MPI 21 (2001) Heat Resistant Enamel, Gloss, (Up to 205 C or 400 F)

MPI 23	(2001) Surface Tolerant Metal Primer
MPI 26	(2001) Cementitious Galvanized Metal Primer
MPI 39	(2001) Interior Latex-based Wood Primer
MPI 45	(2001) Interior Primer Sealer
MPI 47	(2001) Interior Alkyd, Semi-Gloss
MPI 50	(2001) Interior Latex Primer Sealer
MPI 52	(2001) Interior Latex, Gloss Level 3
MPI 54	(2001) Interior Latex, Semi-Gloss
MPI 79	(2001) Marine Alkyd Metal Primer
MPI 94	(2001) Exterior Alkyd, Semi-Gloss
MPI 95	(2001) Fast Drying Metal Primer
MPI 101	(2001) Cold Curing Epoxy Primer
MPI 107	(2001) Rust Inhibitive Primer (Water-Based)
MPI 108	(2001) High Build Epoxy Marine Coating
MPI 110	(2001) Interior/Exterior High Performance Acrylic
MPI 134	(2001) Waterborne Galvanized Primer
MPI 141	(2001) High Performance Semigloss Latex, White and Tints - Gloss Level 5
MPI 147	(2001) Institutional Low Odor / VOC Interior Latex, Gloss Level 5

## U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101	(Rev. B) Color Code for Pipelines and for Compressed Gas Cylinders
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## SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS-EPP-SP01-01	(2001) Environmentally Preferable Product Specification for Architectural and Anti-Corrosive Paints
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## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PA 1	(2000) Shop, Field, and Maintenance Painting
SSPC PA 3	(1995) Safety in Paint Application
SSPC VIS 1	(1989) Visual Standard for Abrasive Blast Cleaned Steel (Standard Reference Photographs)

SSPC VIS 3	(1993) Visual Standard for Power- and Hand-Tool Cleaned Steel (Standard Reference Photographs)
SSPC VIS 4	(2001) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning
SSPC SP 10	(1994) Near-White Blast Cleaning
SSPC SP 12	(1995) Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultra high-Pressure Water Jetting Prior to Recoating

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

In keeping with the intent of Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition", products certified by SCS as meeting SCS-EPP-SP01-01 shall be given preferential consideration over registered products. Products that are registered shall be given preferential consideration over products not carrying any EPP designation.

### SD-02 Shop Drawings

Piping identification

Submit color stencil codes

## SD-03 Product Data

Coating

Manufacturer's Technical Data Sheets

## SD-04 Samples

Color; G

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

## SD-07 Certificates

Applicator's qualifications

Qualification Testing laboratory for coatings

## SD-08 Manufacturer's Instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

## SD-10 Operation and Maintenance Data

Coatings

Preprinted cleaning and maintenance instructions for all coating systems shall be provided.

## 1.3 APPLICATOR'S QUALIFICATIONS

## 1.3.1 Contractor Qualification

Submit the name, address, telephone number, FAX number, and e-mail address of the contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years. List information by individual and include the following:

- a. Name of individual and proposed position for this work.
- b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address, telephone number, and telex number (if non-US) of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

#### 1.4 QUALITY ASSURANCE

##### 1.4.1 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph "Sampling Procedures." Test each chosen product as specified in the paragraph "Testing Procedure." Products which do not conform, shall be removed from the job site and replaced with new products that conform to the referenced specification. Testing of replacement products that failed initial testing shall be at no cost to the Government.

##### 1.4.1.1 Sampling Procedure

The Contracting Officer will select paint at random from the products that have been delivered to the job site for sample testing. The Contractor shall provide one quart samples of the selected paint materials. The samples shall be taken in the presence of the Contracting Officer, and labeled, identifying each sample. Provide labels in accordance with the paragraph "Packaging, Labeling, and Storage" of this specification.

##### 1.4.1.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph "Qualification Testing" laboratory for coatings. The qualification testing lab report shall include the backup data and summary of the test results. The summary shall list all of the reference specification requirements and the result of each test. The summary shall clearly indicate whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If the Contractor chooses MPI to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

## 1.5 REGULATORY REQUIREMENTS

### 1.5.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

### 1.5.2 Lead Content

Do not use coatings having only lead.

### 1.5.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

### 1.5.4 Asbestos Content

Materials shall not contain asbestos.

### 1.5.5 Mercury Content

Materials shall not contain mercury or mercury compounds.

### 1.5.6 Silica

Abrasive blast media shall not contain free crystalline silica.

### 1.5.7 Human Carcinogens

Materials shall not contain ACGIH Limit Values and ACGIH TLV-DOC confirmed human carcinogens (A1) or suspected human carcinogens (A2).

## 1.6 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

## 1.7 SAFETY AND HEALTH

Apply coating materials using safety methods and equipment in accordance with the following:

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01525, "Safety Requirements" and in Appendix A of EM 385-1-1. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

### 1.7.1 Safety Methods Used During Coating Application

Comply with the requirements of SSPC PA 3.

### 1.7.2 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.
- b. 29 CFR 1910.1000.
- c. ACGIH Limit Values, threshold limit values.

## 1.8 ENVIRONMENTAL CONDITIONS

### 1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

## 1.9 COLOR SELECTION

Colors of finish coats shall be as indicated or specified. Where not indicated or specified, colors shall be selected by the Contracting Officer. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors approximate colors indicated and the product conforms to specified requirements.

Tint each coat progressively darker to enable confirmation of the number of coats.

Color, texture, and pattern of wall coating systems shall be as indicated.

## 1.10 LOCATION AND SURFACE TYPE TO BE PAINTED

### 1.10.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

- a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.
- b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

- c. Factory finished items required to match adjacent surfaces, including roof accessories.

#### 1.10.1.1 Exterior Painting

Includes new surfaces of the building and appurtenances as indicated.

#### 1.10.1.2 Interior Painting

Includes new surfaces of the building and appurtenances as indicated. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

- a. Exposed columns, girders, beams, joists, and metal deck; and
- b. Other contiguous surfaces.

#### 1.10.2 Painting Excluded

Do not paint the following unless indicated otherwise.

- a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.
- b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, below raised access flooring, elevator shafts and chases. Gypsumboard railing and door frames in attic of base bid shall be painted.
- c. Steel to be embedded in concrete.
- d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.
- e. Hardware, fittings, and other factory finished items.

#### 1.10.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior surfaces.

- a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.
  - (1) Exposed piping, conduit, and ductwork;
  - (2) Supports, hangers, air grilles, and registers;
  - (3) Miscellaneous metalwork and insulation coverings.
- b. Do not paint the following, unless indicated otherwise:
  - (1) Zinc-coated, aluminum, and copper surfaces under insulation
  - (2) Aluminum jacket on piping
  - (3) Interior ferrous piping under insulation.

### 1.10.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes. Clean the surfaces to remove dust, dirt, rust, and loose mill scale. Immediately after cleaning, provide the metal surfaces with one coat primer per schedules. Shield sprinkler heads with protective covering while painting is in progress. Upon completion of painting, remove protective covering from sprinkler heads. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Provide primed surfaces with the following:

- a. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material. In lieu of red enamel finish coat, provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals.
- b. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel applied to a minimum dry film thickness of 1.0 mil. Provide piping with 2 inch wide red enamel bands or self-adhering red plastic bands spaced at maximum of 20 foot intervals throughout the piping systems.

### 1.10.4 Definitions and Abbreviations

#### 1.10.4.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

#### 1.10.4.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

#### 1.10.4.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

## 1.10.4.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

## 1.10.4.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

## 1.10.4.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

## 1.10.4.7 EXT

MPI short term designation for an exterior coating system.

## 1.10.4.8 INT

MPI short term designation for an interior coating system.

## 1.10.4.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

## 1.10.4.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

## 1.10.4.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

## 1.10.4.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D 523. Historically, the

Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

#### 1.10.4.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

#### 1.10.4.14 Paint

See Coating definition.

#### 1.10.4.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

#### 1.10.4.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

### PART 3 EXECUTION

#### 3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

#### 3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

#### 3.3 PREPARATION OF METAL SURFACES

### 3.3.1 New Ferrous Surfaces

- a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6, or SSPC SP 10. Brush-off blast remaining surface in accordance with SSPC SP 7; Water jetting to SSPC SP 12 WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.
- b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/SSPC SP 12 WJ-3 or SSPC SP 10/SSPC SP 12 WJ-2 as applicable.

### 3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

For abrasive blast cleaned surfaces, the requirements are stated in SSPC SP 7, SSPC SP 6, and SSPC SP 10. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 1.

For waterjet cleaned surfaces, the requirements are stated in SSPC SP 12. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 4.

### 3.3.3 Galvanized Surfaces

- a. New Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, steam, or non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D 2092, Appendix X2, and remove by one of the methods described therein.
- b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

### 3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

- a. Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

### 3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

#### 3.4.1 Concrete and Masonry

- a. Curing: Concrete and masonry surfaces shall be allowed to cure at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting.
- b. Surface Cleaning: Remove the following deleterious substances.
  - (1) Dirt, Chalking, Grease, and Oil: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.
  - (2) Fungus and Mold: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.
  - (3) Paint and Loose Particles: Remove by wire brushing.
  - (4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.
- c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.
- d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water.

#### 3.4.2 Gypsum Board and Veneer Plaster

- a. Surface Cleaning: Veneer plaster shall be clean and free from loose matter; gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.
- b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.
- c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. New veneer plaster to be coated shall have a maximum moisture content of 8 percent, when measured in accordance with ASTM D 4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new veneer plaster to age a minimum of 30 days before preparation for painting.

### 3.5 PREPARATION OF WOOD AND PLYWOOD SURFACES

### 3.5.1 New Plywood and Wood Surfaces, Except Floors:

- a. Wood surfaces shall be cleaned of foreign matter.

Surface Cleaning: Surfaces shall be free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood.

- b. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter in accordance with ASTM D 4444, Method A, unless otherwise authorized.
- c. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints.
- d. Cracks and Nailheads: Set and putty stop nailheads and putty cracks after the prime coat has dried.
- e. Cosmetic Repair of Minor Defects:

(1) Knots and Resinous Wood: Prior to application of coating, cover knots and stains with two or more coats of 3-pound-cut shellac varnish, plasticized with 5 ounces of castor oil per gallon. Prime before applying any putty over shellacked area.

(2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.

(3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.

## 3.6 APPLICATION

### 3.6.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. For piping in unfinished spaces, provide primed surfaces with one coat of red alkyd gloss enamel to a minimum dry film thickness of 1.0 mil. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. For piping in finished areas, provide prime surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel. Upon completion of painting, remove protective covering from sprinkler heads.

- a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.
- b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.
- c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

### 3.6.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

### 3.6.3 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

#### 3.6.4 Coating Systems

- a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table

Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table

Division 4. Interior Concrete Masonry Units Paint Table

Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table

Division 6. Interior Wood Paint Table

Division 9: Interior Veneer Plaster, Gypsum Board, Paint Table

- b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.
- c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

#### 3.7 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.
- b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.
- c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.
- d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.
- e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.
- f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

#### 3.8 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 9 for Interior.

### 3.9 COATING SYSTEMS FOR WOOD AND PLYWOOD

- a. Apply coatings of Tables in Division 6 for Interior.
- b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.

### 3.10 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with MIL-STD-101. Place stenciling in clearly visible locations. On piping not covered by MIL-STD-101, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

### 3.11 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

### 3.12 PAINT TABLES

All DFT's are minimum values.

#### 3.12.1 EXTERIOR PAINT TABLES

##### DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

##### STEEL / FERROUS SURFACES

- A. New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

1. Alkyd

New; MPI EXT 5.1Q-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 23	MPI 94	MPI 94
System DFT: 5.25 mils		

- B. New Steel that has been blast-cleaned to SSPC SP 6:

1. Alkyd

New; MPI EXT 5.1D-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 79	MPI 94	MPI 94
System DFT: 5.25 mils		

- C. New steel blast cleaned to SSPC SP 10:

1. Waterborne Light Industrial

MPI EXT 5.1R-G5 (Semigloss)

## STEEL / FERROUS SURFACES

Primer:	Intermediate:	Topcoat:
MPI 101	MPI 108	MPI 110-G5
System DFT: 8.5 mils		

## EXTERIOR GALVANIZED SURFACES

## D. New Galvanized surfaces:

## 1. MPI EXT 5.3A-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 26	MPI 11	MPI 11
System DFT: 4.5 mils		

## 2. MPI EXT 5.3H-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 134	MPI 11	MPI 11
System DFT: 4.5 mils		

## 3. Waterborne Primer / Waterborne Light Industrial Coating

## MPI EXT 5.3J-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 134	MPI 110-G5	MPI 110-G5
System DFT: 4.5 mils		

## MPI EXT 5.3J-G6 (Gloss)

Primer:	Intermediate:	Topcoat:
MPI 134	MPI 110-G6	MPI 110-G6
System DFT: 4.5 mils		

## E. Galvanized surfaces with slight coating deterioration; little or no rusting:

## 1. Waterborne Light Industrial Coating

## MPI REX 5.3J-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 134	N/A	MPI 110-G5
System DFT: 4.5 mils		

## EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)

## F. Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment. Match surrounding finish:

## 1. MPI EXT 5.4F-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 95	MPI 94	MPI 94
System DFT: 5 mils		

## G. Surfaces adjacent to painted surfaces; Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish:

## 1. MPI EXT 5.1D-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 79	MPI 94	MPI 94

## EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)

System DFT: 5.25 mils

## H. Hot metal surfaces including flues subject to temperatures up to 205 degrees C (400 degrees F):

## 1. Heat Resistant Enamel

MPI EXT 5.2A

Primer: Intermediate: Topcoat:  
 MPI 21 Surface preparation and number of coats per  
 manufacturer's instructions.  
 System DFT: Per Manufacturer

## I. Ferrous metal subject to high temperature, up to 400 degrees C (750 degrees F):

## 1. Inorganic Zinc Rich Coating

MPI EXT 5.2C

Primer: Intermediate: Topcoat:  
 MPI 19 Surface preparation and number of coats per  
 manufacturer's instructions.  
 System DFT: Per Manufacturer

## 2. Heat Resistant Aluminum Enamel

MPI EXT 5.2B (Aluminum Finish)

Primer: Intermediate: Topcoat:  
 MPI 2 Surface preparation and number of coats per  
 manufacturer's instructions.  
 System DFT: Per Manufacturer

## 3.12.2 INTERIOR PAINT TABLES

## DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

## A. New Concrete masonry:

## 1. MPI INT 4.2D-G5 (Semigloss)

Filler	Primer:	Intermediate:	Topcoat:
MPI 4	N/A	MPI 141	MPI 141
System DFT: 11 mils			

Fill all holes in masonry surface

## DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

## INTERIOR STEEL / FERROUS SURFACES

## A. Metal, Mechanical, Electrical, Fire extinguishing sprinkler systems including valves, conduit, hangers, supports, Surfaces adjacent to painted surfaces (Match surrounding finish), exposed copper piping, and miscellaneous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment:

## 1. Alkyd

MPI INT 5.1E-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 79	MPI 47	MPI 47

## INTERIOR STEEL / FERROUS SURFACES

System DFT: 5.25 mils

- B. Hot metal surfaces including flues subject to temperatures up to 205 degrees C (400 degrees F):

## 1. Heat Resistant Enamel

MPI INT 5.2A

Primer:	Intermediate:	Topcoat:
MPI 21	Surface preparation and number of coats per	manufacturer's instructions.

System DFT: Per Manufacturer

- C. Ferrous metal subject to high temperature, up to 400 degrees C (750 degrees F):

## 1. Inorganic Zinc Rich Coating

MPI INT 5.2C

Primer:	Intermediate:	Topcoat:
MPI 19	Surface preparation and number of coats per	manufacturer's instructions.

System DFT: Per Manufacturer

## DIVISION 6: INTERIOR WOOD PAINT TABLE

- A. New Wood and plywood not otherwise specified:

## 1. MPI INT 6.4S-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 39	MPI 141	MPI 141

System DFT: 4.5 mils

## 2. MPI INT 6.4B-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 45	MPI 47	MPI 47

System DFT: 4.5 mils

## 3. Institutional Low Odor / Low VOC Latex

New; MPI INT 6.3V-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 39	MPI 147	MPI 147

System DFT: 4 mils

## DIVISION 9: INTERIOR VENEER PLASTER, GYPSUM BOARD, PAINT TABLE

- A. New Veneer Plaster and Wallboard not otherwise specified:

1. New; MPI INT 9.2A-G3 (Eggshell) / Existing; RIN 9.2A-G3 (Eggshell)  
(Rooms A119 and D112 only)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 52	MPI 52

System DFT: 4 mils

New; MPI INT 9.2A-G5 (Semigloss) / Existing; RIN 9.2A-G5 (Semigloss)

Primer:	Intermediate:	Topcoat:
MPI 50	MPI 54	MPI 54

DIVISION 9: INTERIOR VENEER PLASTER, GYPSUM BOARD, PAINT TABLE  
System DFT: 4 mils

-- End of Section --

## SECTION 09915

COLOR SCHEDULE  
06/93

## PART 1 GENERAL

## 1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. When color is not designated for items, the Contractor shall propose a color for approval.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-04 Samples

## Color Schedule; G

Two sets of color boards, 90 days after the Contractor is given Notice to proceed, complying with the following requirements:

- a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
- b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.
- c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.
- d. Samples for this color board are required in addition to samples requested in other specification sections.
- e. Color boards shall be submitted to the following addresses:  
ROICC Office, Project Manager and the office of Project Architect.

## PART 2 PRODUCTS

## 2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

## 2.2 COLOR SCHEDULE

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors. Refer to Drawing Sheets A-601 and A-602.

PART 3 EXECUTION (Not Applicable)

-- End of Section --

## SECTION 10100A

VISUAL COMMUNICATIONS SPECIALTIES  
11/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM F 148	(1995) Binder Durability of Cork Composition Gasket Materials

## 1.2 GENERAL REQUIREMENTS

The term visual display board when used herein includes marker boards, tackboard strips, board cases, projection screens (motorized and manual), and horizontal sliding units. Visual display boards shall be from manufacturer's standard product line.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Visual Display Boards; G

Manufacturer's descriptive data and catalog cuts. Manufacturer's installation instructions, and cleaning and maintenance instructions.

## SD-04 Samples

## Aluminum; G

Sections of frame, map rail, and chalktray, and two map hooks.

## Porcelain Enamel; G

Section showing porcelain enamel coating, steel, core material and backing.

## Materials; G

Section of core material showing the lamination of colored cork, natural cork, woven fabric, non-woven fabric, and vinyl wall covering. Sample of hardwood and plastic laminate finish, and glass type. Samples shall be minimum 4 by 4 inches and show range of color.

## SD-07 Certificates

### Visual Display Boards

Certificate of compliance signed by Contractor attesting that visual display boards conform to the requirements specified.

## 1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered to the building site in the manufacturer's original unopened containers and shall be stored in a clean dry area with temperature maintained above 50 degrees F. Materials shall be stacked according to manufacturer's recommendations. Visual display boards shall be allowed to acclimate to the building temperature for 24 hours prior to installation.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## PART 2 PRODUCTS

### 2.1 COLOR

Finish colors for required items shall be as specified in indicated.

### 2.2 MATERIALS

#### 2.2.1 Porcelain Enamel

Marker board writing surface shall be composed of porcelain enamel fused to a nominal 28 gauge (0.0149 inches) thick steel, laminated to a minimum 1/4 inch thick core material with a steel or foil backing sheet. Writing surface shall be capable of supporting paper by means of magnets.

#### 2.2.2 Cork

Cork shall be a continuous resilient sheet made from soft, clean, granulated cork relatively free from hardback and dust and bonded with a binder suitable for the purpose intended. The wearing surface shall be free from streaks, spots, cracks or other imperfections that would impair its usefulness or appearance. The material shall be seasoned, and a clean cut made not less than 1/2 inch from the edge shall show no evidence of soft sticky binder.

##### 2.2.2.1 Colored Cork

Colored cork shall be composed of pure cork and natural color pigments that are combined under heat and pressure with linseed oil. Colored cork shall be colored throughout and shall be washable. The burlap backing shall be

deeply imbedded and keyed to the work sheet being partially concealed in it and meeting the requirements of ASTM F 148.

### 2.2.3 Aluminum (Markerboards)

Aluminum frame extrusions shall be alloy 6063-T5 or 6063-T6, conform to ASTM B 221, and be a minimum 0.06 inches thick. Exposed aluminum shall have an anodized, satin finish. Straight, single lengths shall be used wherever possible. Joints shall be kept to a minimum. Corners shall be mitered and shall have a hairline closure.

### 2.2.4 Hardwood (Projection Screen Housings)

Exposed hardwood for frames, cabinets, and cases shall be oak, walnut or mahogany. Hardwood shall be provided with a durable factory-applied stain and lacquer finish of a type standard with the manufacturer.

## 2.3 MARKERBOARD

Markerboard shall have a porcelain enamel writing surface and a chalktray. Markerboard shall be a factory assembled unit complete in one piece, without joints whenever possible. When markerboard dimensions require delivery in separate sections, components shall be prefit at the factory, disassembled for delivery and jointed at the site. Frame shall be aluminum.

Chalktray shall be the same material as the frame and extend the full length of the liquid markerboard. The markerboard shall have a map rail. The map rail with a tackable insert shall extend the full length of the liquid chalkboard, and shall have map hooks with clips for holding sheets of paper. Two map hooks shall be provided for each 4 foot of map rail. Dry erase markings shall be removable with a felt eraser or dry cloth without ghosting. Each unit shall come complete with an eraser and four different color compatible dry erase markers. The size shall be as indicated.

## 2.4 DISPLAY TRACK SYSTEM

Display track system shall be similar to Claridge HS416 with fixed panel with four sliding panels on two tracks.

## 2.5 HORIZONTAL SLIDING UNITS

The horizontal sliding unit shall be composed of a fixed back panel, sliding panels, an aluminum track assembly, and shall have a map rail and chalktray. The unit shall have 2 tracks. The fixed back panel shall be markerboard. The unit shall have four marker board sliding panels. The track assembly and exposed members, including panel edging and chalktray, shall be extruded aluminum. Frame assembly shall be reinforced at corners.

Sliding panels shall be suspended from the top and shall slide over the aluminum track using molded nylon ball bearing rollers at the top of the track and nylon guide rollers at the bottom of the track to eliminate vibration and to provide quiet and smooth operation of the panels. Sliding panels shall have finger pulls at each end. The map rail shall have a tackable insert and extend the length of the horizontal sliding unit. The map rail shall have map hooks with clips for holding sheets of paper. Two map hooks shall be provided for each 4 foot of map rail. Chalktray shall extend the full length of the horizontal sliding unit. Dry erase markings on the marker board shall be removable with a felt eraser or dry cloth without ghosting. Each unit shall come complete with an eraser and four different color compatible dry erase markers. The size shall be as

indicated.

## 2.6 PROJECTION SCREENS

### 2.6.1 Electric Screens

Recessed mount motorized projection screen shall have 120V motor that is lubricated for life, quick reversal type, has overload protector, integral gears, and preset accessible limit switches. Recessed mount projection screens shall have an operable closure door and access panel. Screen shall be flame retardant, mildew resistant, and non-supported vinyl tab tensioned with brightness gain of 1.3. Tab tensioned screens shall have a vinyl surface that is stretchable. Bottom of screen fabric shall be weighted with metal rod. Roller shall be a rigid metal at least 3 inches in diameter mounted on sound absorbing supports. Motor will be end mounted or motor-in-roller design. Screen shall have a 3 position control switch to stop or reverse screen at any point. The switch shall be installed in a flush electrical box with cover plate, location(s) as shown on the electrical drawings. All conduit and wiring from the control switch to the projection screen shall be furnished and installed by the Contractor. Ceiling recessed case shall be extruded aluminum UL approved for plenum installation. The size shall be 70 inches by 70 inches viewing area.

### 2.6.2 Manual Screens

Wall mounted with minimal extension brackets, manual projection screen (quantity 5). Screen shall be flame retardant, mildew resistant, washable with microscopic glass beads embedded into fabric and coated. Black masking borders shall be provided. Rollers shall be manufacturers standard with nylon bearings. Case finish shall be of a washable fabric. Mount top of screen 8 inches below finished ceiling. Screen size shall be 60 inches by 60 inches viewing area.

## PART 3 EXECUTION

### 3.1 PLACEMENT SCHEDULE

Location and mounting height of visual display boards shall be as indicated.

### 3.2 INSTALLATION

Installation and assembly shall be in accordance with manufacturer's printed instructions. Concealed fasteners shall be used. Visual display boards shall be attached to the walls with suitable devices to anchor each unit. The Contractor shall furnish and install trim items, accessories and miscellaneous items in total, including but not limited to hardware, grounds, clips, backing materials, adhesives, brackets, and anchorages incidental to or necessary for a sound, secure, complete and finished installation. Installation shall not be initiated until completion of room painting and finishing operations. Visual display boards shall be installed in locations and at mounting heights indicated. Visual display boards shall be installed level and plumb, and if applicable doors shall be aligned and hardware shall be adjusted. Damaged units shall be repaired or replaced by the Contractor as directed by the Contracting Officer.

### 3.3 CLEANING

Writing surfaces shall be cleaned in accordance with manufacturer's instructions.

-- End of Section --

## SECTION 10160A

TOILET PARTITIONS  
07/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167 (1996) Stainless and Heat-Resisting  
Chromium-Nickel Steel Plate, Sheet, and  
Strip

## FEDERAL SPECIFICATIONS (FS)

FS RR-P-1352C Partitions, Toilet, Complete

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60003 Partitions, Toilet, Complete

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Toilet Partition System

Drawings showing plans, elevations, details of construction, hardware, reinforcing, fittings, mountings, and anchorings.

## SD-03 Product Data

## Toilet Partition System

Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

## SD-04 Samples

## Toilet Partition System; G

Manufacturer's hinge assembly, brackets, color charts and color samples.

### 1.3 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated; free from dust, water, or other contaminants; and shall have easy access for inspection and handling.

### 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 TOILET ENCLOSURES

Toilet enclosures shall conform to CID A-A-60003, Type I, Style C, overhead braced. Width, length, and height of toilet enclosures shall be as shown. Panels indicated to receive toilet paper holders or grab bars as specified in Section 10800 TOILET ACCESSORIES, shall be prepared for mounting of the items required. Grab bars shall withstand a bending stress, shear stress, shear force, and a tensile force induced by 250 lbf. Grab bars shall not rotate within their fittings. Toilet partition systems shall be provided by Capitol Partitions, Inc., COMTEC, or Santana Products, Inc.

#### 2.1.1 Pilaster Shoes

ASTM A 167, type 302/304 stainless steel, not less than 3 inches high, 20 gauge, finished to match hardware.

#### 2.1.2 Panels

Panels shall be anchored to front pilasters with with a continuous "U" channel and shall be provided with continuous double ear brackets (panel height) for all panel to wall connections and continuous single ear brackets (panel height) for all pilaster to wall connections. Brackets shall be heavy extruded brite anodized type 6463T5 aluminum.

#### 2.1.3 Hardware and Fittings

Hardware - compartments shall be supplied with all hardware and fasteners for a complete installation. Doors shall be hung on 1/8 inch thick heavy extruded brite anodized type 6463T5 aluminum hinges 8 inches high which shall wrap around both the door and pilaster. Hinges shall be fastened to door and pilaster with minimum 4 one-way head thru-bolts and fastened to the edge of the door and pilaster with #10 x 1 inch screws. Top hinges shall have opposing nylon cams which shall be factory set at 30 degrees open for in-swing and closed for out-sing. Top hinge shall be reinforced with a 1/4 inch stainless steel rod. Fittings - all brackets shall be heavy extruded brite anodized type 6463T5 aluminum. Floor and wall fasteners shall be #14 x 1-3/4 inch "Pro-Star" tamper-proof screws with conical plastic anchors. All other fasteners shall be 5/8 inch stainless steel "Pro-Star" tamper-proof screws. Headrail brackets shall be 20 gauge type 304 stainless steel with brushed finish.

#### 2.1.4 Anchorage and Fasteners

Manufacturer's standard exposed and concealed fasteners of non-magnetic

stainless steel, finished to match hardware with theft-resistant type heads and nuts.

#### 2.1.5 Floor-Supported Partitions

Furnish galvanized steel anchorage devices, complete with threaded rods, lock washers and leveling adjustment nuts at pilasters to permit structural connection at floor. Furnish shoe at each pilaster to conceal anchorage.

#### 2.1.6 Heat-Sink Strip

Manufacturer's standard continuous, extruded aluminum strip in manufacturer's standard finish. Provide heat-sink strip at all panels and doors.

#### 2.1.7 Fabrication

##### 2.1.7.1 General

Furnish standard doors, panels, screens, and pilasters fabricated for partition system, unless otherwise indicated. Furnish units with cutouts, drilled holes and internal reinforcement to receive partition-mounted hardware, accessories, and grab bars, as indicated.

##### 2.1.7.2 Door Dimensions

Unless otherwise indicated, furnish 24 inch wide inswinging doors for ordinary toilet stalls and minimum 32 inch wide (clear opening) outswinging doors at stalls equipped for use by handicapped. Provide doors for toilet partitions.

##### 2.1.7.3 Hardware

Furnish hardware for each compartment in partition system, as follows:

- a. Latch and Keeper: Manufacturer's standard surface-mounted latch unit, designed for emergency access and for handicapped accessibility, with combination rubber-faced door strike and keeper.
- b. Door Pull: Manufacturer's standard unit. Provide pulls on both faces of handicapped compartment doors.
- c. Robe Hook (RH): Manufacturer's standard unit, combination hook and rubber-tipped bumpers. Provide where indicated in toilet cubicles.

#### 2.2 HARDWARE

Hardware for the toilet partition system shall conform to CID A-A-60003 for the specified type and style of partitions. Hardware finish shall be highly resistant to alkalies, urine, and other common toilet room acids.

#### 2.3 COLORS

Color of finishes for toilet partition system components shall be manufacturer's standard as indicated.

#### 2.4 FINISHES

Partitions, panels, screen, and door finishes shall conform to FS RR-P-1352C

and the requirements specified.

#### 2.4.1 Finish No. 5

Solid plastic fabricated of polymer resins formed under high pressure forming a single component section not less than one inch thick. Colors shall extend throughout the panel thickness. Exposed finish surfaces shall be smooth, waterproof, non-absorbent, and resistant to staining and marking with pens, pencils, or other writing devices. Solid plastic partitions shall not show any sign of deterioration when immersed in the following chemicals and maintained at temperature of 27 degrees C for a minimum of 30 days:

Acetic Acid (80%)	Hydrochloric Acid (40%)
Acetone	Hydrogen Peroxide (30%)
Ammonia (liquid)	Isopropyl Alcohol
Ammonia Phosphate	Lactic Acid (25%)
Bleach (12%)	Lime Sulfur
Borax	Nicotine
Brine	Potassium Bromide
Caustic Soda	Soaps
Chlorine Water	Sodium Bicarbonate
Citric Acid	Trisodium Phosphate
Copper Chloride	Urea; Urine
Core Oils	Vinegar

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Toilet partitions shall be installed straight and plumb in accordance with approved manufacturer's instructions with horizontal lines level and rigidly anchored to the supporting construction. Where indicated, anchorage to walls shall be by toggle-bolting. Drilling and cutting for installation of anchors shall be at locations that will be concealed in the finished work.

#### 3.2 ADJUSTING AND CLEANING

Doors shall have a uniform vertical edge clearance of approximately 3/16 inch and shall rest open at approximately 30 degrees when unlatched. Toilet partitions shall be cleaned in accordance with approved manufacturer's instructions and shall be protected from damage until accepted.

-- End of Section --

## SECTION 10201N

## METAL WALL LOUVERS

09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 603.8 (1992; Addendum 1993) Pigmented Organic Coatings on Extruded Aluminum

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500 (1991) Louvers, Dampers and Shutters

AMCA 511 (1991) Certified Ratings Program for Air Control Devices

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 221 (1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

## SD-02 Shop Drawings

Wall louvers; G

Show all information necessary for fabrication and installation of louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

## SD-04 Samples

Wall louvers; G

Colors of finishes shall closely approximate colors indicated. Where color is not indicated, custom color shall be selected by the Contracting Officer.

## 1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers shall be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Extruded Aluminum

ASTM B 221, alloy 6063-T5 or -T52.

### 2.2 METAL WALL LOUVERS

Weather resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. The rating shall show a water penetration of 0.20 or less ounce per square foot of free area at a free velocity of 800 feet per minute.

#### 2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

#### 2.2.2 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions for all louvers more than 5 feet in width at not more than 5 feet on centers. Provide mullions covers on both faces of joints between louvers.

#### 2.2.3 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

### 2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers. Provide other accessories as required for complete and proper installation.

### 2.4 FINISHES

#### 2.4.1 Aluminum

Provide factory-applied organic coating.

##### 2.4.1.1 Organic Coating

Clean and prime exposed aluminum surfaces and apply a baked enamel finish conforming to AAMA 603.8, 0.8 mil minimum dry film thickness, color as indicated or as selected.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with

manufacturer's recommendations.

3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.2.4 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

## SECTION 10270A

RAISED ACCESS FLOOR (RAF) SYSTEM  
01/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## CEILINGS &amp; INTERIOR SYSTEMS CONTRACTORS ASSOCIATION (CISCA)

CISCA Access Floors (1987) Recommended Test Procedures for Access Floors

## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO Building Code (1997) Uniform Building Code (3 Vol.)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3 (1995) High-Pressure Decorative Laminates

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75 (1999) Protection of Electronic Computer/Data Processing Equipment

NFPA 99 (1999) Health Care Facilities

## 1.2 SYSTEM DESCRIPTION

Raised access flooring shall be installed at the location and elevation and in the arrangement shown on the drawings. The floor system shall be of the bolted stringer type, complete with all supplemental items, and shall be the standard product of a manufacturer specializing in the manufacture of raised access floor systems.

## 1.2.1 Floor Panels

Floor panel testing shall be conducted in accordance with CISCA Access Floors. When tested as specified, all deflection and deformation measurements shall be made at the point of load application on the top surface of the panel. Floor panels shall be capable of supporting 1250 pounds concentrated load without deflecting more than 0.080 inch and without permanent deformation in excess of 0.010 inch in any of the specified tests. Floor panels shall be capable of supporting 350 pounds per square foot uniform live load without deflection more than 0.040 inch.

Floor panels shall be capable of supporting 800 pounds rolling load without deflecting more than 0.040 inch and without permanent deformation in excess of 0.020 inch. In accordance with CISCA Access Floors, the permanent deformation limit under rolling load shall be satisfied in all of

the specified tests. In the specified tests, the permanent deformation shall be measured after 10 passes with Wheel 1 and after 10,000 passes with Wheel 2.

#### 1.2.2 Stringers

Stringers shall be capable of supporting a 250 pound concentrated load at midspan without permanent deformation in excess of 0.010 inch.

#### 1.2.3 Pedestals

Pedestals shall be capable of supporting a 5000 pound axial load without permanent deformation.

#### 1.2.4 Pedestal Adhesive

Adhesive shall be capable of securing a pedestal in place with sufficient bonding strength to resist an overturning force of 1000 inch pounds.

#### 1.2.5 Bond Strength of Factory Installed Floor Covering

Bond strength of floor covering shall be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to 1000 pounds, without separation of the covering from the panel.

#### 1.2.6 Leakage

When the space below the finished floor is to be an air plenum, air leakage through the joints between panels and around the perimeter of the floor system shall not exceed 0.1 cubic foot of air per minute per linear foot of joint subjected to 0.1 inch, water gauge, positive pressure in the plenum.

#### 1.2.7 Grounding

The raised access floor system shall be grounded for safety hazard and static suppression.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Raised Access Floor System; G

Drawings showing layout of the work, sizes and details of components, details at floor perimeter, bracing to resist seismic or other lateral loads, typical cutout details including size and shape limitation, method of grounding, description of shop coating, and installation height above structural floor.

#### SD-03 Product Data

#### Raised Access Floor System; G

Manufacturer's descriptive data, catalog cuts, and installation instructions. The data shall include information about any design and production techniques, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacturer of their components or products. Cleaning and maintenance instructions shall be included. Design calculations which demonstrate that the proposed floor system meets requirements for seismic loading, prepared in accordance with subparagraph Underfloor Bracing under paragraph PANEL SUPPORT SYSTEM and ICBO Building Code. Certified copies of test reports may be submitted in lieu of calculations.

#### SD-04 Samples

##### Raised Access Floor System; G

One sample of each panel type and suspension system proposed for use.

#### SD-06 Test Reports

##### Tests; G

##### Testing of Electrical Resistance; G

Certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

#### SD-07 Certificates

##### Raised Access Floor System

Certificate of compliance attesting that the raised access floor system meets specification requirements.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be stored in original protective packaging in a safe, dry, and clean location and shall be handled in a manner to prevent damage. Panels shall be stored at temperatures between 40 and 90 degrees F, and between 20 percent and 70 percent humidity.

### 1.5 EXTRA MATERIALS

Spare floor panels, spare complete pedestal assemblies, and spare stringers shall be furnished at the rate of one panel for each 750 or fraction thereof required except a minimum of 10 each shall be provided for each plastic laminate, perforated plastic laminate and carpet type with electrical box cutout. Provide ten additional electrical boxes and ten of every type device plates.

### 1.6 OPERATION AND MAINTENANCE MANUALS

Provide maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, require submittal of maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish.

## PART 2 PRODUCTS

### 2.1 FLOOR PANELS

#### 2.1.1 Panel Construction

Except for edge panels, panel size shall be 24 by 24 inches. Finished panels shall be within a 0.010 inch tolerance of the nominal size, and shall be square within a tolerance of 0.015 inch measured corner-to-corner. The top surface of panels shall be flat within a 0.020 inch tolerance measured corner-to-corner. Panels shall be permanently marked to indicate load rating and model number.

##### 2.1.1.1 Hollow Formed Steel Panels (For Plastic Laminate and Plastic Laminate Perforated Panels)

Steel panels shall be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets. Panels shall be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

##### 2.1.1.2 Metal-Clad Cementitious Fill Panel (Composite Panels) (For Carpet Surfaced Panels)

Composite panels shall be of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet shall be completely filled with an incombustible cementitious or concrete material. All cuts into panel shall be sealed or wrapped to prevent dusting of plenum areas.

#### 2.1.2 Floor Covering

Floor panels shall be surfaced with materials firmly bonded in place with waterproof adhesive. Carpet shall be supplied by carpet tile supplier to raised access floor manufacturer; see carpet tile specified in Section 09685N CARPET TILE. Bolt heads or similar attachments shall not rise above the traffic surface.

##### 2.1.2.1 High Pressure Laminate

High pressure laminate surfacing shall conform to NEMA LD 3, Grade HW 62. Total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 150,000 ohms and 20,000,000,000 ohms.

##### 2.1.2.2 Carpet

Carpet surfacing shall be factory installed using one full carpet square per panel. Carpet shall be as supplied by carpet tile manufacturer specified in Section 09685N CARPET TILE.

#### 2.1.3 Edge Strip

Panels shall be edged with extruded vinyl edge strips secured in place with mechanical interlock or adhesive bond, or shall be of a replaceable type. Top of strip shall be approximately 1/8 inch wide, and shall be flush with the floor surfacing.

#### 2.1.4 Accessories

Perforated panels and plenum dividers shall be provided where indicated, and shall be the manufacturer's standard type. Perforated panels shall be designed to support the same static loads as floor panels without structural failure, and shall be capable of delivering the air volumes indicated. Perforated panels shall be 25 percent open area and shall be equipped with adjustable dampers.

#### 2.1.5 Resilient Base

Resilient base is specified in Section 09650A RESILIENT FLOORING.

#### 2.1.6 Lifting Device

Provide four lifting devices for each type floor panel provided that is standard with the floor manufacturer.

#### 2.1.7 Electrical Boxes

Electrical floor boxes shall be Maxcess Technologies, Inc. Model EB30 or equal consisting of a minimum 2 mm galvanized steel box and a hinged high impact plastic lid with recess for carpet installation. On lifting edge of lid, serrations shall be provided for exposed wiring to pass through lid when lid is in closed position.

### 2.2 PANEL SUPPORT SYSTEM

#### 2.2.1 Pedestals

Pedestals shall be of galvanized steel. Pedestal base plates shall provide a minimum of 16 square inches of bearing surface and shall be a minimum of 1/8 inch thick at 2 feet - 0 inches high raised access flooring. Provide 25 square inch bearing surface at pedestals supporting the 3 feet - 6 inch high raised access flooring. Pedestal shafts shall be threaded to permit height adjustment within a range of approximately 2 inches, to permit overall floor adjustment within plus or minus 0.10 inch of the required elevation, and to permit leveling of the finished floor surface within 0.062 inch in 10 feet in all directions. Locking devices shall be provided to positively lock the final pedestal vertical adjustments in place. Pedestal caps shall interlock by bolting with stringers to preclude tilting or rocking of the panels.

#### 2.2.2 Bolted Stringers

Bolted stringers shall be of rolled steel and shall interlock with the pedestal heads to prevent lateral movement.

### 2.3 FASCIA

Aluminum or steel fascia plates shall be provided at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates shall have a factory applied baked enamel finish. Finish on aluminum plates shall be as standard with the floor system manufacturer. Fascia plates shall be reinforced on the back, and shall be supported using the manufacturer's standard lateral bracing at maximum 4 feet on center. Trim, angles, and fasteners shall be provided as required.

## 2.4 STEPS

Steps shall be securely fastened to the raised access floor system and to the structural floor. Construction shall include standard floor system components and custom components as required, and shall include all supports, fasteners, and trim necessary for a finished installation. Step nosings, and threshold strips shall be cast or extruded aluminum with nonslip traffic surfaces.

### 2.4.1 Steps

Height of risers shall not exceed 7 inches. Steps shall be designed to support a uniform load of 150 pounds per square foot. Treads shall be surfaced with the manufacturer's standard nonslip floor finish.

## 2.5 RAILINGS

Railings shall be the double rail and post type, fabricated of at least 1-1/2 inch round o.d. railings and 1-3/4 inch o.d. posts with a satin natural anodized finish. Square minimum 1-1/2 inch seamless aluminum tubing may be used for posts in lieu of round. At steps, the top rail shall be approximately 36 inches high and parallel to the incline. The top rail shall be 42 inches high at open ends of the floor. Guardrails shall have intermediate rails or an ornamental pattern such that a sphere 4 inches in diameter cannot pass thru.

## 2.6 TESTS

Raised access flooring shall be factory tested by an independent laboratory at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

### 2.6.1 Load Tests

Floor panel, stringer, and pedestal testing shall be conducted in accordance with CISCA Access Floors.

## 2.7 Test for Bond Strength of Factory Installed Floor Covering

The test panel shall be supported on pedestals and stringers as specified for the installed floor. The supports shall be braced as necessary to prevent sideways movement during the test. A test load of 1000 pounds shall be imposed on the test assembly through a hard plastic caster 3 inches in diameter and 1 inch wide. The caster shall be rolled completely across the center of the panel. The panel shall withstand 20 passes of the caster with no delamination or separation of the covering.

## 2.8 COLOR

Color shall be as indicated and where not indicated as selected by the Contracting Officer.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The floor system shall be installed in accordance with the manufacturer's instructions and with the approved detail drawings. Open ends of the

floor, where the floor system does not abut wall or other construction, shall have positive anchorage and rigid support. Areas to receive raised flooring shall be maintained between 60 and 90 degrees F, and between 20 percent and 70 percent humidity for 24 hours prior to and during installation.

### 3.1.1 Preparation for Installation

The area in which the floor system is to be installed shall be cleared of all debris. Structural floor surfaces shall be thoroughly cleaned and all dust shall be removed. Floor coatings required for dust or vapor control shall be installed prior to installation of pedestals only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, the coating shall be applied after the pedestals have been installed and the adhesive has cured.

### 3.1.2 Pedestals

Pedestals shall be accurately spaced, and shall be set plumb and in true alignment. Base plates shall be in full and firm contact with the structural floor. All pedestals shall be glued with every third base receiving two steel expansion anchors.

### 3.1.3 Stringers

Stringers shall be interlocked and bolted with the pedestal caps to preclude lateral movement, and shall be spaced uniformly in parallel lines at the indicated elevation. Flooring shall be 4 feet by 4 feet basketweave pattern layout or 4 feet with 2 feet stringer configuration.

### 3.1.4 Auxiliary Framing

Auxiliary framing or pedestals shall be provided around columns and other permanent construction at open ends of the floor and beneath panels that are substantially cut to accommodate utility systems. Special framing for additional lateral support shall be as shown on the approved detail drawings.

### 3.1.5 Panels

The panels shall be interlocked with supports in a manner that will preclude lateral movement. Perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps must be fastened to the supporting components to form a rigid boundary for the interior panels. Floors shall be level within 1/16 inch measured with a 10 foot straightedge in all directions. Cut edges of steel panels shall be painted as recommended by the panel manufacturer. Cut edges of composite panels shall be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer. Extruded vinyl edging shall be secured in place at all cut edges of all panel cut-outs to prevent abrasion of cables. Where the space below the floor is a plenum, cutouts for conduit and similar penetrations shall be closed using self-extinguishing sponge rubber.

### 3.1.6 Fascia Plates

Exposed floor ends and exposed openings of ramps and stairs shall be covered with aluminum or steel closures.

### 3.1.7 Repair of Zinc Coating

Zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, shall be repaired by the application of a galvanizing repair paint. Areas to be repaired shall be thoroughly cleaned prior to application of the paint.

### 3.2 TESTING OF ELECTRICAL RESISTANCE

Testing of electrical resistance in the completed installation shall be conducted in the presence of the Contracting Officer. Testing shall be in accordance with NFPA 99 modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Measurements shall be made at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity shall be 45 to 55 percent and temperature shall be 69 to 75 degrees F. The panels used in the testing will be selected at random and will include two panels most distant from the ground connection. Electrical resistance shall be measured with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal shall not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, shall be in accordance with paragraph FLOOR COVERING.

### 3.3 CLEANING AND PROTECTION

#### 3.3.1 Cleaning

The space below the completed floor shall be free of all debris. Before any traffic or other work on the completed raised floor is started, the completed floor shall be cleaned in accordance with the floor covering manufacturer's instructions.

#### 3.3.2 Protection

Traffic areas of raised floor systems shall be protected with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cutouts shall be covered with material of sufficient strength to support the loads to be encountered. Plywood or similar material shall be placed on the floor to serve as runways for installation of heavy equipment. Protection shall be maintained until the raised floor system is accepted.

### 3.4 FIRE SAFETY

An automatic detection system shall be installed below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 and shall sound an audible and visual alarm. Air space below the raised floor shall be subdivided into areas not exceeding 10,000 square feet by tight, noncombustible bulkheads. All penetrations for piping and cables shall be sealed to maintain bulkhead properties.

-- End of Section --

## SECTION 10350

## FLAGPOLES

**11/98**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 241\B 241M (1996) Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

ASTM C 94 (1996) Ready-Mixed Concrete

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

## 1.2.1 SD-02 Shop Drawings

## a. Flagpoles

Submit complete detail drawings, flagpole and base, erection and installation details for products listed below. Indicate dimensions, construction details, general layout, jointing, grounding method, and installation with relation to the building construction.

## 1.2.2 SD-03 Product Data

## a. Flagpoles

Provide flagpoles manufacturer's descriptive data, catalog cuts, specifications, and recommended installation methods of the modular signage systems.

## 1.2.3 SD-04 Samples

## a. Flagpoles G

## b. Accessories G

Provide samples of finished metal for flagpoles and accessories.

## 1.3 QUALITY ASSURANCE

## 1.3.1 Manufacturing Standards

Provide flagpole as a complete unit produced by a single manufacturer, including fittings, accessories, base, and anchorage devices.

### 1.3.2 Design Criteria

Provide flagpole and installations constructed to withstand a 90-mph wind velocity minimum when flying flag of appropriate size. Use heavy pipe sizes if required for flagpole type and height shown.

### 1.3.3 Pole Construction

Construct pole and ship to site in one piece if possible. If more than one piece is necessary, provide snug-fitting, precision joints with self-aligning, internal splicing sleeve arrangement for weather-tight, hairline field joints.

## 1.4 DELIVERY, STORAGE, AND HANDLING

### 1.4.1 General

Spiral wrap flagpole with heavy Kraft paper or other weather-tight wrapping and prepare for shipment in hard fiber tube or other protective container.

Deliver flagpole and accessories completely identified for installation procedure. Handle and store flagpole to prevent damage or soiling.

## PART 2 PRODUCTS

### 2.1 FLAGPOLES

#### 2.1.1 Aluminum Flagpoles

Fabricate from seamless extruded tubing complying with ASTM B 241\B 241M, alloy 6063-T6, having a minimum wall thickness of 3/16 inches, tensile strength not less than 30,000 psi, and a yield point of 25,000 psi. Heat-treat and age-harden after fabrication. Exposed height shall be 30 feet. Butt diameter shall be 6 inches. Top diameter shall be 88 mm. Wall thickness shall be minimum 3/16 inches. Tapered length shall be 3353 mm. Straight length shall be 19 feet. Ball diameter shall be 6 inches.

Provide cone-tapered aluminum flagpole.

### 2.2 FLAGPOLE MOUNTING

Provide manufacturer's standard base system for the type of flagpole installation required.

#### 2.2.1 Base Plate

For anchor-bolt mounting, furnish manufacturer's standard cast metal shoe base of same material as flagpole. Furnish and install anchor bolts and lightning ground spike as required.

#### 2.2.2 Foundation Tube

For ground-set flagpole, provide 16-gage minimum galvanized corrugated steel tube, or 12-gage rolled steel tube, sized to suit flagpole and installation. Furnish complete with welded steel bottom base and support plate, lightning ground spike, and steel centering wedges, all welded construction. Provide loose hardwood wedges at top for plumbing pole after erection. Galvanize steel parts after assembly, including foundation tube.

Provide manufacturer's standard flash collar, finished to match flagpole.

### 2.3 SHAFT FINISH

Finish designations prefixed by "AA" conform to the Aluminum Association system for aluminum finishes. Provide fine, directional, medium satin polish (AA-M32), finished as follows:

- a. Natural Clear Anodized finish complying with AA-C22A41, Class I (0.7 mil).

### 2.4 FITTINGS

#### 2.4.1 Finial Ball

Manufacturer's standard flush-seam ball, size as indicated or, if not indicated, to match pole butt diameter.

14-gage spun aluminum finished to match pole shaft.

#### 2.4.2 Truck

Ball-bearing, nonfouling, revolving, double-track assembly of cast metal finished to match pole shaft.

#### 2.4.3 Cleats

Two 9 inch cast metal cleats with fasteners, finished to match pole shaft.

#### 2.4.4 Halyards

Provide two continuous halyards for flagpole, as follows:

- a. Polypropylene, braided, white.
- b. Size: 5/16 inch.

#### 2.4.5 Halyard Flag Snaps

Provide two swivel snaps per halyard, as follows:

- a. Chromium plated bronze.

## PART 3 EXECUTION

### 3.1 PREPARATION FOR GROUND-SET POLE

#### 3.1.1 Excavation

Excavate for foundation concrete to neat clean lines in undisturbed soil. Provide forms where required due to unstable soil conditions. Remove wood, loose soil, rubbish, and other foreign matter from excavation; and moisten earth before placing concrete. Backfill open excavation after concreting with original excavated material.

#### 3.1.2 Concrete

Provide concrete composed of portland cement, coarse and fine aggregate, and water mixed in proportions to attain 28-day compressive strength of not

less than 3000 psi, complying with ASTM C 94.

Place concrete immediately after mixing. Compact concrete in place by use of vibrators. Moist-cure exposed concrete for not less than seven days, or use a nonstaining curing compound in cold weather.

Finish trowel exposed concrete surfaces to smooth, dense surface. Provide positive slope for water runoff to base perimeter.

### 3.2 FLAGPOLE INSTALLATION

#### 3.2.1 General

Prepare and install flagpoles where shown and in compliance with accepted shop drawings and manufacturer's instructions.

Provide positive lightning ground for flagpole installation.

Paint below-grade portions of ground-set flagpole with heavy coat of bituminous paint.

-- End of Section --

## SECTION 10430A

## EXTERIOR SIGNAGE

06/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 505

(1988) Metal Finishes Manual for  
Architectural and Metal Products

## 1.2 GENERAL

All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Recyclable materials shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

## 1.3 CHARACTER PROPORTIONS AND HEIGHTS

Letters and numbers on indicated signs for handicapped-accessible buildings shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Approved Detail Drawings; G

Drawings showing elevations of each type of dimensional building letters; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included.

## SD-03 Product Data

#### Dimensional building letters

Manufacturer's descriptive data and catalog cuts.

#### Installation

Manufacturer's installation instructions and cleaning instructions.

#### SD-04 Samples

##### Dimensional building letters; G

One 12 inch length of framing for illuminated signs. One sample of letter. Samples may be installed in the work, provided each sample is identified and location recorded. Two samples of manufacturer's standard color chips for each material requiring color selection.

#### SD-10 Operation and Maintenance Data

##### Protection and Cleaning

Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed.

### 1.5 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 5 years prior to bid opening.

### 1.6 DELIVERY AND STORAGE

Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## PART 2 PRODUCTS

### 2.1 DIMENSIONAL BUILDING LETTERS

#### 2.1.1 Fabrication

Letters shall be fabricated from cast aluminum. Letters shall be cleaned by chemical etching or cleaned ultrasonically in a special degreasing bath. Letters shall be packaged for protection until installation.

#### 2.1.2 Typeface

Typeface shall be Berling Bold upper case.

#### 2.1.3 Size

Letter size shall be as indicated.

#### 2.1.4 Finish

Baked enamel or finish shall be provided.

#### 2.1.5 Mounting

Threaded studs of number and size as recommended by manufacturer, shall be used for concealed anchorage. Letters which project from the building line shall have stud spacer sleeves. Letters, studs, and sleeves shall be of the same material. Templates for mounting shall be supplied.

#### 2.1.6 Messages

Messages shall be as indicated.

### 2.2 ORGANIC COATING

Surfaces shall be cleaned, primed, and given a semi-gloss baked enamel finish in accordance with NAAMM AMP 505 with total dry film thickness not less than 1.2 mils.

### 2.3 COLOR, FINISH, AND CONTRAST

Color of products shall be as indicated.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces shall not be installed until finishes on such surfaces have been completed.

#### 3.1.1 Anchorage

Anchorage and fastener materials shall be non-ferrous and in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry.

#### 3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Signs shall be cleaned, as required, at time of cover removal.

-- End of Section --

## SECTION 10440A

## INTERIOR SIGNAGE

06/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1997) Designation System for Aluminum Finishes

AA 46 (1978) Anodized Architectural Aluminum

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605.2 (1995) High Performance Organic Coatings on Architectural Extrusions and Panels

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.2.1 (1996) Square and Hex Bolts and Screws Inch Series

ANSI B18.6.1 (1981; R 1997) Wood Screws (Inch Series)

ANSI B18.6.2 (1972; R 1993) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws

ANSI B18.6.3 (1972; R 1991) Machine Screws and Machine Screw Nuts

ANSI B18.7 (1972; R 1992) General Purpose Semi-Tubular Rivets, Full Tubular Rivets, Split Rivets and Rivet Caps

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 26/B 26M (1996a) Aluminum-Alloy Sand Castings

ASTM B 108 (1996a) Aluminum-Alloy Permanent Mold Castings

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221 (2000) Aluminum and Aluminum-Alloy Extruded

## Bars, Rods, Wire, Profiles, and Tubes

## ARCHITECTURAL &amp; TRANSPORTATION BARRIERS COMPLIANCE BOARD (ATBCB)

ATBCB ADA TITLE III

(1990) Americans with Disabilities Act -  
Buildings and Facilities

## FEDERAL SPECIFICATIONS (FS)

FS FF-S-325

Shield, Expansion; Nail, Expansion; and  
Nail, Drive Screw (Devices, Anchoring,  
Masonry)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Modular signage system; G

Drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location, each sign type, and message shall be included.

## SD-03 Product Data

Installation

Modular signage system

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

## SD-04 Samples

Interior Signage; G

Modular signage system; G

One sample of each of the following sign types showing typical quality and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

- a. Directional sign.
- b. Door identification sign.

Two samples of manufacturer's standard color chips for each material requiring color selection.

## SD-10 Operation and Maintenance Data

### Approved Manufacturer's Instructions Protection and Cleaning

Six copies of operating instructions outlining the step-by-step procedures required for system operation shall be provided. The instructions shall include simplified diagrams for the system as installed. Six copies of maintenance instructions listing routine procedures, repairs, and guides shall be provided. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number.

#### 1.3 GENERAL

Interior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Recyclable materials shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

##### 1.3.1 Character Proportions and Heights

Letters and numbers on indicated signs in handicapped-accessible buildings, which do not designate permanent rooms or spaces, shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted. Suspended or projected overhead signs shall have a minimum character height of 3 inches.

##### 1.3.2 Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms)

Letters and numbers on indicated signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be raised 1/32 inch upper case, helvetica medium type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 inch in height, but no higher than 2 inches. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 inches minimum in height. Indicated accessible facilities shall use the international symbol of accessibility.

#### 1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 5 years prior to bid opening.

#### 1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area in accordance with manufacturer's instructions.

## 1.6 EXTRA STOCK

The Contractor shall provide 10 extra frames and extra stock of the following: 10 blank plates of each color and size for modular sign system. 10 pressure-sensitive letters in each color and size for sign for modular sign system. 10 changeable message strips for sign type for modular sign system.

## PART 2 PRODUCTS

### 2.1 ROOM IDENTIFICATION/DIRECTIONAL MODULAR SIGNAGE SYSTEM

#### 2.1.1 Construction

The modular signage system assemblies shall consist of three primary elements, a structural rail (with coordinating rail joiners to increase sign height in the field) removable copy inserts and interlocking end caps or frame, and trim.

The internal structural rail shall consist of a 6063T5 alloy per ASTM B 221 extruded aluminum rail, which is the structural member of each sign. The following is one structural rail design in the system:

- a. A one-sided (7.1 mm overall thickness) structural rail design that allows copy to be inserted on only one side, where indicated.

##### 2.1.1.1 Inserts

The signage rails shall be designed as to accept ABS plastic signage inserts.

##### 2.1.1.2 Insert Fabrication

The insert is the signage member to which message signage copy in the form of letters, numbers, and/or symbols shall be applied, and shall be interchangeable with similar sized rails of any other sign of equal or greater width and height. The ends of the rail and insert assembly shall be enclosed by end caps of prefinished 6063T5 extruded aluminum. Inserts shall be fabricated from 0.090 minimum ultra-violet resistant thickness extruded ABS Acrylic sheet core with 20.003 polycarbonate non-glare clear cap bonded to the core during the extrusion texturing process.

##### 2.1.1.3 End Caps

The end caps shall be interchangeable to either end of each sign type, and any other similar sign of equal height. The end caps shall be interlocking mechanically with the inserts, and rail, requiring no tools for assembly. Vandal-resistant end caps and frames are attached with stainless steel screws. End caps shall utilize round corners or bullnose shape. Spring clips shall be steel. Plastic spring clips are not acceptable.

##### 2.1.1.4 Trim

Optional accessory top and bottom trim frames of prefinished (color as indicated) 6063T5 extruded aluminum shall be provided to the signage types indicated. Trim shall utilize a bullnose shape.

#### 2.1.2 Mounting

Mounting of the modular signage system shall include surface mounting with screw-on applications for interior and exterior walls and on selected doors as indicated, at the locations indicated, and other mounting devices as typically required for a particular signage type and location in accordance to the manufacturer's standard recommendations.

Provide matte finish plaques in sizes as indicated. Toilet signage (Sign Type I) shall conform to ATBCB ADA TITLE III. All signage shall conform to ADA.

#### 2.1.2.1 Mechanical Fasteners

Provide countersunk mounting holes in plaques and mounting screws.

#### 2.1.3 Graphics Applications

##### 2.1.3.1 Tactile Letters and Symbols

Chemically weld tactile letters and symbols 0.8 mm minimum thick acrylic message letters to front surface of signage inserts where indicated and where required by ATBCB ADA TITLE III. Tactile letters shall be at least 16 mm high but no higher than 51 mm with a stroke width of at least 6 mm.

##### 2.1.3.2 Braille

Grade II Braille. Provide Grade II Braille inlaid strip as indicated to match sign color.

##### 2.1.3.3 Vinyl Images

Apply message symbols or graphic design to panel using vinyl topically applied copy (non-tactile). Injection molded or extruded ABS plastic or aluminum insert with topically applied high performance cast PVC vinyl copy.

#### 2.1.4 Plaque Messages

Message content shall be as directed by the Contracting Officer. Bids shall be based on 12 letters and 3 digits for each sign.

- a. Typeface: Helvetica Medium.
- b. Type size: As indicated.
- c. Background color: As indicated.
- d. Message color: As indicated.

#### 2.1.5 ALUMINUM ALLOY PRODUCTS

ASTM B 209 for aluminum sheet or plate, ASTM B 221 for aluminum extrusions and ASTM B 26/B 26M or ASTM B 108 for aluminum castings, as applicable. Provide aluminum extrusions at least 3 mm thick and aluminum plate or sheet at least 16 gauge thick. Provide aluminum castings of solid aluminum cast certified by AA 46 alloy designation B443.0. Where anodic coatings are specified, alloy shall conform to Aluminum Association's alloy designation 514.0 or A514.0.

#### 2.1.6 ANODIC COATING

Clean and provide exposed aluminum surfaces with an anodized finish, AA DAF-45.

- a. Integral color anodized designation AA M10-C22-A32, Architectural Class II (0.4 to 0.7 mil). Color as indicated.

#### 2.1.7 ORGANIC COATING

Clean, prime and provide exposed aluminum surfaces with a baked enamel finish, AAMA 605.2, and total dry film thickness not less than 1.2 mils. Color as indicated.

#### 2.1.8 FABRICATION AND MANUFACTURE

##### 2.1.8.1 Factory Workmanship

Holes for bolts and screws, drill or punch holes to produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Conceal fastenings where practicable and as indicated.

##### 2.1.8.2 Dissimilar Materials

Where dissimilar metals are in contact or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, protect surfaces with two coats of epoxy primer at 3.0 mils dry film thickness (DFT) each coat and finish with one coat of latex paint at 2.0 mils DFT to prevent galvanic or corrosive action.

#### 2.1.9 COLOR, FINISH, AND CONTRAST

Color shall be as indicated. In buildings required to be handicapped-accessible, the characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

### 2.2 BUILDING DIRECTORIES

Building directories shall be lobby directory and shall be provided with floor plans, a changeable directory listing consisting of the areas, offices and/or personnel located within the facility. Dimensions, details, and materials of sign shall be as shown on the drawings. Where required, message content shall be as shown on drawings. Messages shall be provided by the Officer in Charge of construction. Plans (graphics) shall be printed on non-glare acrylic with background and graphics colors selected from non-glare automotive acrylic lacquers.

#### 2.2.1 Header Panel

Header panel shall be acrylic with raised acrylic letters.

#### 2.2.2 Doors

##### 2.2.2.1 Door Glazing

Door glazing shall be clear acrylic sheet minimum 3/16 inch thick.

#### 2.2.2.2 Door Construction

Extruded aluminum door frame shall be of same finish as surrounding frame. Corners shall be mitered, welded, and assembled with concealed fasteners. Hinges shall be standard with the manufacturer, in finish to match frames and trim. Glazing shall be set in frame with resilient glazing channels.

#### 2.2.2.3 Door Locks

Door locks shall be manufacturer's standard, and shall be keyed alike.

#### 2.2.3 Fabrication

Extruded aluminum frames and trim shall be assembled with corners welded and mitered to a hairline fit, with no exposed fasteners.

#### 2.2.4 Changeable Letter/Message Strip Directory System

Directory shall consist of a non-illuminated] unit with step or groove, laser or rotary engraved removable name strips. Design of unit shall be as shown in the drawings.

##### 2.2.4.1 Construction

The directory shall be constructed of an aluminum 2-1/2 inch deep frame with satin dark bronze anodized finish. Unit shall be surface mounted. Unit shall have a 3 inch high header with lettering as shown. Unit shall have a 3/8 inch face concealed hinge door and locking system. Door frame shall be aluminum with satin dark bronze finish.

##### 2.2.4.2 Colors

Colors for background, graphics, and name strips shall be as selected by the Contracting Officer.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

Examine condition of locations and surfaces on which signs and directory will be installed. Do not proceed with installation until defects or errors which would result in poor installation have been corrected.

#### 3.2 INSTALLATION

Directory and signs shall be installed in accordance with approved manufacturer's instructions. Illuminated signage shall be in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Required blocking shall be installed as detailed. Signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be installed on the wall adjacent to the latch side of the door as indicated. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall as indicated. Mounting location for such signage shall be so that a person may approach within 3 inches of signage without encountering protruding objects or standing within the swing of a door. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on

glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer's instructions.

### 3.3 ANCHORS AND FASTENERS

Provide anchorage to ensure that directory and signs are fastened securely in place. Anchorage not otherwise specified or indicated shall include machine sheet metal screws and expansion shields when approved for concrete and masonry; machine and through bolts for steel; and screws for wood.

All fasteners and anchors shall be stainless steel; exposed fasteners (where applicable) shall have matching color to adjacent sign finish.

#### 3.3.1 Expansion Shields

Provide lead expansion shields 51 mm minimum length with continuous exterior spiral threads for stainless steel screws and bolts that shall be recessed not less than 64 mm into concrete or masonry.

#### 3.3.2 Wood Screws

Wood screws shall be stainless steel conforming to ANSI B18.6.1.

#### 3.3.3 Wedge Bolts

Expansion wedge bolts (where indicated or required) conforming to FS FF-S-325 Group II, Type IV, Class 1, Type 304 stainless steel for bolts, wedges, nuts and washers.

#### 3.3.4 Sheet Metal Screws, Bolts, Nuts, Studs, and Rivets

Shall be stainless steel conforming to ANSI B18.2.1, ANSI B18.6.3, and ANSI B18.7.

#### 3.3.5 Screws

All screws shall be stainless steel conforming to ANSI B18.2.1, ANSI B18.6.1, ANSI B18.6.2, and ANSI B18.6.3 and shall be provided with lead expansion shields for installation in masonry. Self-tapping stainless steel flathead screws shall be provided for installation to light gage metal substrates.

### 3.4 Protection and Cleaning

The work shall be protected against damage during construction. Wrap finished work with paper, polyethylene film, or strippable waterproof tape from shipment and storage and protect from damage during installation. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with the manufacturer's approved instructions.

### 3.5 ADJUST AND CLEAN

Repair damage to directory and signs incurred during installation. Replace signs which cannot be repaired to new condition. Clean glass, frames, and other sign surfaces, adjust hardware for proper operation.

### 3.6 SIGN TYPES (BASED ON "SYSTEM 2/90," MODULAR FACILITY SIGNAGE)

Manufacturers names and numbers are provided for color, texture, pattern

and quality of material identification only. Products of other manufacturers shall be accepted for use subject to approval of the Contracting Officer, only if they match the colors, finishes, textures, and patterns of the manufacturer listed, and meet the technical and performance requirements of the related materials and products in this specification section.

**Sign Type 1**

ADA Bathroom Sign: 8x8HT, 203 mm high by 223 mm wide sign consisting of (1) 152 mm by 203 mm insert with 102 mm tactile symbol, centered, and (1) 51 mm by 203 mm insert with 19 mm applied tactile copy, centered, all caps, with 13 mm braille strip, screw mount.

**Sign Type 2**

Room Signs: 4x8BT, 102 mm by 223 mm wide sign consisting of a top 51 mm by 203 mm insert with 25 mm applied tactile centered, all caps, and a bottom 51 mm by 203 mm insert with 16 mm applied vinyl copy, centered, upper and lower case, with 13 mm braille strip, screw mount. Additional rail with endcaps, rail joiner and inserts located as indicated when required by Contracting Officer.

-- End of Section --

## SECTION 10800A

TOILET ACCESSORIES  
04/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036 (1991; R 1997) Flat Glass

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-2380 (Rev A)(Canc. Notice 1) Dispenser, Paper Towel

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Finishes; G  
Accessory Items; G

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

## SD-04 Samples

Finishes; G  
Accessory Items; G

One sample of each accessory proposed for use. Approved samples may be incorporated into the finished work, provided they are identified and their locations noted.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area protected from construction damage and vandalism.

## 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## PART 2 PRODUCTS

### 2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Porcelain type, tile-wall accessories are specified in Section 09310 CERAMIC TILE. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

#### 2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall be of tamperproof design and shall be finished to match the accessory.

#### 2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

Metal _____	Finish _____
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

### 2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

#### 2.2.1 Grab Bar (GB)

Grab bar shall be 18 gauge, 1-1/4 inches OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Exposed mounting flange shall have mounting holes concealed. Grab bar shall have peened non-slip surface. Installed bars shall be capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 1-1/2 inch.

#### 2.2.2 Mirrors, Glass (MG)

Glass for mirrors shall be Type I transparent flat type, Class 1-clear. Glazing Quality q1 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent

"adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

#### 2.2.2.1 Mirror Accessories

- a. Mastic: Mastic for setting mirrors shall be a polymer type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Mastic shall be compatible with mirror backing paint, and shall be approved by mirror manufacturer.
- b. Mirror Frames: Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 1-1/4 x 1/4 x 1/4 inch continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.
- c. Mirror Clips: Concealed fasteners of type to suit wall construction material shall be provided with clips.

#### 2.2.3 Paper Towel Dispenser (PTD)

Paper towel dispenser shall conform to CID A-A-2380, Type I, shall be constructed of not less than 0.269 inch Type 304 stainless steel, and shall be surface mounted. Locking mechanism shall be concealed tumbler key lock.

#### 2.2.4 Sanitary Napkin Disposer (SND)

Sanitary napkin disposal shall be constructed of Type 304 stainless steel with removable leak-proof receptacle for disposable liners. Fifty disposable liners of the type standard with the manufacturer shall be provided. Receptacle shall be retained in cabinet by tumbler lock. Disposer shall be provided with a door for inserting disposed napkins, and shall be surface mounted on walls or toilet partitions as indicated.

#### 2.2.5 Soap Dispenser (SD)

Soap dispenser shall be counter mounted, liquid type consisting of a polyethylene tank with a minimum 32 fluid ounces holding capacity and a 6 inch spout length.

#### 2.2.6 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be with two rolls of standard tissue mounted horizontally. Cabinet shall be stainless steel, satin finish.

#### 2.2.7 Mop Rack (In each Janitor Room)

Stainless steel, 22 gauge, 18.8 (Type 302), satin finish. Three mop and broom spring loaded holders, rubber cam with plated steel retainer. Length shall be 24 inches.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

### 3.2 CLEANING

Material shall be cleaned in accordance with manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring of surfaces.

-- End of Section --

## SECTION 10990

MISCELLANEOUS SPECIALTIES  
05/01

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Miscellaneous Specialty Items; G

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates.

## SD-04 Samples

## Miscellaneous Specialty Items; G

Samples of the following items: Fabric and color samples for materials. Samples shall be of actual finish materials, taken from manufacturer's stock.

## 1.2 GENERAL REQUIREMENTS (MISCELLANEOUS SPECIALTY ITEMS)

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included.

## PART 2 PRODUCTS

## 2.1 FIRE EXTINGUISHER CABINETS

Provide fire extinguisher cabinets size 7 inches depth by 10 inches width by 27 inches height for housing the fire extinguisher which will be provided by the Government. Verify size of cabinets with Contracting Officer. Bids shall be based on inside box dimensions 24 inches high by 9 inches wide by 6 inches deep. Provide semi-recessed box fabricated from no lighter than 20 gauge cold-rolled steel. Box shall have baked-on enamel finish in white. All trim corners shall be mitered. Provide doors and trim constructed of extruded aluminum. All door corners shall be mitered. Doors shall be 1/2 inch thick, hollow metal design and shall have a continuous piano hinge and pull handle with self-adjusting roller catch. The door shall be full tempered glass. Hinge design shall permit door to open 180 degrees. Fire extinguisher lettering shall be white, vinyl

die-cut letters, vertically ascending.

## 2.2 RECESSED FLOOR MATTING

Provide recessed floor mat of hinged aluminum tread rails fabricated from extruded 6063-T6 alloy. Tread spacing shall be 2 inches on centers. Rail and bar shall be standard mill finish. Aluminum angle frame shall be 1/2 inch deep with 1/8 inch wide exposed surface aluminum 6063-T5 alloy. Provide black vinyl fillers as required for achieving 2 inch standard spacing of rails. Latex leveling screed shall be provided to ensure level base. Provide heavy duty carpet insert treads of 100 percent solution dyed nylon, cut pile carpet. Carpet fiber shall be fusion bonded to a rigid backing permitting mechanical insertion into tread rail. Carpet inserts shall be free of splices. Carpet color as indicated.

## 2.3 GRANITE WINDOW STOOLS

Granite window stools shall be fabricated of natural granite with a machine honed-polished finish. Anchorage and setting shall be as required by the manufacturer. Natural variations and markings that are characteristic of the quarry shall be acceptable provided they do not impair its strength or durability. Color shall be as selected by Architect from a minimum of eight manufacturer's standard colors in a middle range pricing group.

## 2.4 BULLET RESISTIVE WINDOW WITH CASH TRAY

Bullet resistive window and cash tray shall be Insulgard Corporation Model SV-3 Readymount Transaction Window System or equal with U.L. resistance label III .44 Magnum, SPSA in accordance with U.L. 752. Windows shall be size as indicated and shall be comprised of solid polymer counter (supplied by Section 06650, "Solid Polymer (Solid Surfacing) Fabrications", stainless steel, cash tray, glazing of IC-322 (clear) glazing with natural voice transmission system at stainless steel jambs and tray. Each window shall be assembled and ready for installation. All components shall be consistent with the threat level specified. Plastic laminate shall be color as selected by Architect.

## 2.5 BULLETPROOF PACKAGE RECEIVER

Bulletproof package receiver shall have nominal 14 inch wide by 13 inch high by 15 inch deep clear inside dimensions. Receiver shall have an inter-locking mechanism to allow only one door at a time to open. The front door shall be lockable from secure side with a special locking bar. Front door shall be provided with a closer. Doors shall be furnished stainless steel with prime painted housing. Receiver shall be Class III rated .44 Magnum, SPSA in accordance with U.L. 752. Bulletproof package receiver shall be factory fabricated by a security equipment manufacturer.

# PART 3 EXECUTION

## 3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to manufacturer's recommendations. Items listed below require additional procedures as specified.

### 3.1.1 Recessed Floor Matting

Set mat at height recommended by manufacturer. Coordinate top of mat with

bottom of doors that swing across ensuring ample clearance between door and mat. Contractor shall verify field measurements prior to releasing materials for fabrication by the manufacturer. A mat frame shall be used to ensure recess accuracy in size, shape and depth. Drain pit shall be formed by blocking out concrete when frames are installed. Pit shall be dampproofed after concrete has set. Frames shall be assembled onsite and installed so that upper edge will be level with finished floor surface. A cement base shall be screeded inside the mat recess frame area using the edge provided by the frame as a guide. The frame shall be anchored into the cement with anchor pins a minimum of 24 inches on centers.

### 3.2 CLEANUP

Clean all installed items at time of installation and again at time of project completion. Provide Contractor with data and requirements to maintain or protect finished work from damage.

-- End of Section --

## SECTION 11162A

DOCK LIFT  
08/00

## PART 1 GENERAL

## 1.1 GENERAL REQUIREMENTS

## 1.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

## 1.1.2 Nameplates

As a minimum, each loading dock leveler shall have the manufacturer's name, address, type or style, model or serial number, rated capacity, and catalog number on a plate secured to the equipment.

## 1.1.3 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Dock Lift; G

Drawings with complete wiring, schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detail drawings shall show proposed layout and anchorage of equipment and appurtenances. Detail drawings shall show the concrete pit details including flush edge angles, dock bumpers, and sloped pit bottom; method of mounting and anchoring; and location of control stations and disconnect switches.

## SD-03 Product Data

## Dock Lift

Data including a complete list of equipment and materials,

manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions.

#### SD-10 Operation and Maintenance Data

##### Dock Lift

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set shall be furnished prior to performance testing and the remainder shall be furnished upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. After approval of the detail drawings, and not later than two months prior to the date of beneficial occupancy, spare parts data for each different item of material and equipment specified are required. The data shall include a complete list of parts and supplies, with current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

#### 1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

### PART 2 PRODUCTS

#### 2.1 DOCK LIFT

Lift shall be for light loading dock activities incorporating pallet jacks or walkies for material movement (not fork lift travel). The lift shall have a 6000 lb. lifting capacity with an axle loading capacity of 3000 lbs. over the ends and 3000 lbs. over the sides, a 6 foot by 8 foot safety tread steel platform with minimum 8 inch bevel toe guards, a 10 inch lowered height, minimum 58 inch travel and 4.67 fpm speed. It shall have a 5 HP-230V/60HZ/3PH continuous duty power unit, NEMA 4 "up", "down" with key lockout weatherproof pendant push button control, 20 foot coil cord for the control, magnetic motor starter and 24-volt control transformer. Toe guards shall be electric and stop operation upon detection of obstruction.

Platform accessories shall include:

- a. Conformance to OSHA, ANSI, CS202-56, BOCA and NEC.
- b. A 5-year structural warranty.
- c. Positive mechanical stops within the hydraulic cylinders.
- d. A 24-volt, 4 amp fused control circuit.
- e. The starter, 3 pole adjustable overloads and 24-volt transformer prewired in a NEMA 12 enclosure with UL approval and label.

- f. A removable safety maintenance leg.
- g. Four heavy-duty torque tubes.
- h. An anodized aluminum hydraulic valve manifold.
- i. A minimum of 3 in-line hydraulic filters.
- j. Minimum 2 inch black and yellow safety markings on the toe guards.
- k. A minimum 2 inch clearance between the bottom of the toe guard and pit floor when the lift is fully lowered.
- l. Lifetime lubricated bearings.
- m. Chrome plated axles, shafts, and rods.
- n. Semi trailer rollover capacity when the lift is fully lowered.
- o. A baked-on enamel paint finish.
- p. 12 inch by 72 inch hinged bridge.
- q. Bridge safety lighting chains.
- r. Removable steel siderailings 4 feet high with midrails.
- s. Front and rear safety chains.
- t. Automatic bridge activator.
- u. Quick disconnect for controls mounted to wall.

#### 2.1.1 Dock Bumpers

A minimum of two high-impact resistant molded rubber or laminated rubber dock bumpers shall be furnished with each loading dock leveler. Dock bumpers shall be installed into face of loading dock (not dock lift).

### 2.2 CORROSION PROTECTION AND PAINTING

#### 2.2.1 Fasteners

Bolts, screws, nuts, and washers shall be coated with hot-dip zinc or cadmium or made of corrosion resistant metal.

#### 2.2.2 Ferrous Metal Surfaces

Ferrous metal surfaces, including coated ferrous and inaccessible ferrous surfaces, but not including bearings, gear contact surfaces, parts protected by lubrication, or other surfaces not usually painted or coated shall be cleaned, and provided with a baked enamel finish.

#### 2.2.3 Nonferrous Parts

Nonferrous parts shall be protected against corrosion as necessary.

#### 2.2.4 Dissimilar Metals

Dissimilar metals, which may be subject to electrolysis upon contact, shall be separated by electrolytically inactive material.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Installation shall be as indicated and in accordance with manufacturer's installation instructions. Dock lift and accessories shall operate easily and perform reliably. Unsatisfactory operation shall result in correction adjustment, or reinstallation until satisfactory performance and operation is achieved and installation is acceptable to the Contracting Officer.

-- End of Section --

## SECTION 11600

## GENERAL CASEWORK AND FURNISHINGS

12/98

## PART 1 GENERAL

## 1.1 SCOPE

The work covered by this section of the specifications consists of furnishing all labor, equipment and materials, and performing all operations for the installation of all equipment and casework in accordance with this section of the specifications and the applicable drawings. Countertops and countertop supports where shown or indicated are included in this section. Solid polymer countertops are specified in Section 06650 SOLID POLYMER FABRICATION.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D 635 (1994) Steel Sheet, Zinc-Coated  
(Galvanized) or Zinc-Iron Alloy-Coated  
(Galvannealed) by the Hot-Dip Process

## U.S. DEPARTMENT OF COMMERCE PRODUCT STANDARDS (PS)

PS-1 (1995) Construction and Industrial Plywood

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Solid woods; G  
Lumber core; G  
Plywoods; G  
Particleboards; G  
Tempered welded fiber; G  
High pressure plastic laminate; G

Submit complete shop drawings which will cover all items described in the equipment schedule and/or as shown on the drawings. In addition, he shall supply five sets of installation drawings.

The Contractor shall furnish equipment contractor verified building measurements as they exist, to insure the proper fitting of all items of equipment furnished by this contractor.

## SD-03 Product Data

Solid woods  
Lumber core  
Plywoods  
Particleboards  
Tempered welded fiber  
High pressure plastic laminate

Submit manufacturer's standard published data clearly showing each and every piece of technical equipment labeled "Center." Clearly show the design and functional features of the item.

Submit manufacturer's construction detail drawings, materials and component descriptions indicating compliance with the Contract Documents.

## SD-04 Samples

Base cabinets; G

Submit one (1) full size sample of finished base cabinet, minimum 35 inch length, with two drawers and cupboard below with adjustable shelf, complete with hardware, and without finished top.

Submit samples of each different top material specified complete with test results.

Submit one (1) full-size sample of finished wall and tall case, minimum 35 inch length, if their basic construction is different from that of the base cabinet.

Samples and certificates approval requirements: Samples and certificates will be submitted to demonstrate Contractor's ability to furnish the required casework and furnishings in accordance with the specifications.

General Contractor shall not award subcontract to casework supplier until Contracting Officer has approved the submitted samples and certificates. Supplier will be permitted only one (1) submission of samples.

Acceptable sample units will be used for comparison inspection at the project. Sample units will be retained until completion and acceptance of the work.

Remove sample units from the premises when directed by the Contracting Officer after final completion of the installation and acceptance of the job.

## SD-07 Certificates

Submit a notarized test report certifying that the exterior finish complies with specified chemical and physical resistance requirements.

Submit a notarized certificate that any polyester or plastic material furnished on project meets the ASTM D 635 Test.

## SD-10 Operation and Maintenance Data

a. All equipment and materials, Data Package 2

Submit in accordance with Section 01781, "Operation and Maintenance Data."

#### 1.4 QUALIFICATIONS

All general casework covered by this specification and accompanying drawings shall be manufactured or furnished by one manufacturer and supplied under his direction to eliminate any divided responsibility.

All prospective bidders not on approved manufacturer list, must provide the following proof of their ability to perform under this contract:

- a. Minimum of five years experience in the manufacture of casework and furnishings as specified herein.
- b. Minimum of five completed installations of equal size and requirements which can be inspected prior to the award of the contract.
- c. Financial and technical resources of sufficient scope to assure prompt and satisfactory performance in the production and delivery of all equipment specified so as not to delay the progress of the work.
- d. Financial and technical resources of sufficient scope to assure prompt and satisfactory installation of casework.

##### 1.4.1 Approved Manufacturers

The listed manufacturer's casework has been determined to be representative of the casework requirements of the owner, and based on their meeting the "Essential Casework Requirements" listed below, are qualified to bid.

- a. Collegedale Casework, Inc., Concept II (overlay) Design incorporating modifications unique to this specification. Note: Exposed end panel faces shall be plastic laminate faced. In Room B101, the front frame shall also be plastic laminate faced.

All manufacturers are cautioned the casework is not necessarily the "standard" of any one manufacturer. All manufacturers shall adhere to these specifications, even though such construction features may vary from standard construction or design practices of the manufacturer.

##### 1.4.2 Additional Approved Manufacturers

The following manufacturers are acceptable provided they meet the requirements of these specifications:

- a. Fisher Hamilton Inc.
- b. Southside Manufacturing Corporation
- c. Peterson

#### 1.5 QUALITY ASSURANCE

It is the intent of the Government to receive bids from all qualified casework manufacturers. The specifications and drawings define and show the essential minimum requirements as to the quality of materials, hardware, finish, construction, design, function, and overall workmanship

of the equipment. All equipment and casework shall comply with these specifications.

Where a definite material or manufacturer is specified, it is not the intent to discriminate against any product of another manufacturer. However, it is the intent of this specification to provide a quality and functional installation of casework, and to exclude inadequate or inferior casework.

#### 1.5.1 Field Measurements

Take field measurements prior to preparation of shop drawings and fabrication where possible to insure proper fitting of work. However, allow for adjustments within specified tolerances wherever taking of field measurements before fabrication might delay work.

#### 1.6 WORK BY CASEWORK CONTRACTOR

Equipment, service fixtures and work by equipment contractor shall include:

- a. Furnishing, delivering to the building, uncrating, setting in place, leveling, and anchoring all casework, shelving and equipment listed in the specifications or equipment schedule and/or shown on the drawings.
- b. Providing electrical or plumbing fixture cutouts for installation of fixtures or fittings by other trades.
- c. Furnishing and installing filler panels and scribes as required for finished installation.
- d. Provide sealants at all locations where casework meets dissimilar materials and where needed to provide a clean looking and waterproof assembly. Sealant shall be clear silicone sealant.
- g. Providing all countertop cutouts for installation of plumbing items.
- h. Removing all debris, dirt, and rubbish accumulated as a result of installation of this equipment, leaving premises broom clean and orderly.

#### 1.7 WORK BY OTHER CONTRACTORS UNDER THIS CONTRACT

Equipment and work "by others" under this contract shall include:

- a. Furnishing, installing and connecting of all fixtures, service lines, drain lines, piping, and conduit within equipment and through, under, or along the backs of working surfaces as required by specification and/or drawings.
- b. Furnishing, installing and connecting all vents, re-vents, steam fitting and special plumbing fixtures or piping to meet local codes, even though not specifically called for in the specifications and/or shown in the drawings.
- c. Furnishing and installation of all rigid or flexible conduit, wire, pulling of wire, fittings and special electrical equipment and accessories, including boxes, receptacles, and flush plates sent loose. Included are those in box curbs or tops which are not

installed at equipment contractor's plant due to inconvenience of shipping. All shall be in accordance with local codes even though not specifically called for in the specifications and/or shown on the drawings.

- e. Providing all framing and reinforcements of walls, floors, and ceilings necessary to adequately support the equipment, and all bucks and plaster grounds required for proper installation of equipment.
- f. Furnishing and miscellaneous materials generally classified as maintenance of supply items.
- g. Providing protection and security by General Contractor during and after casework installation. Any resulting damages to casework or thief of component parts shall be the responsibility of the General Contractor.

#### 1.8 PRODUCT HANDLING

Deliver equipment and casework only after wet operations in building are completed.

Store completed equipment and casework in a ventilated place, protected from the weather, with relative humidity therein of 50 percent or less and temperature no greater than 70 degrees F.

#### 1.9 ROUGH-INS

Rough-ins have been established based on the contract drawings. If these must be relocated because of dimensional changes by the successful bidder, the Contractor shall be responsible for any cost incurred by other trades to make the necessary changes.

#### 1.10 COLOR SELECTION

Colors shall be as indicated.

#### 1.11 SCOPE OF WORK

The casework and furnishings specified in this section shall apply to all casework.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Solid Woods

Solid woods shall be properly air-dried, then kiln dried to 5 percent to 6 percent moisture content, and then tempered in inside storage to a moisture content of 6 percent to 8 percent. Woods showing on exposed surfaces shall be oak, carefully selected for color and grain. Woods used in interior construction may be maple, birch, or other suitable hardwoods, clear and sound.

##### 2.1.2 Lumber Core

Lumber core shall be balanced construction consisting of a solid hardwood

stave core, hardwood cross plies, and face veneers of 1/28 inch selected oak. Lumber core for doors shall additionally include an internal end band. Lumber core shall conform to ANSI/HPMA HP 1983 product standards.

### 2.1.3 Plywoods

Plywoods shall be balanced veneer core construction glued with water resistant resin adhesives. Hardwood plywoods for exposed surfaces shall have plastic laminate finish. Plywood for interior and unexposed surfaces may be hard or soft wood plywoods conforming to U.S. Department of Commerce Voluntary Product Standard PS-1.

### 2.1.4 Particleboards

Particleboards shall be nominal 45 pound density industrial boards, mat-formed as flat panels, bonded together with synthetic resin under heat and pressure, conforming to commercial standard CS-236.

### 2.1.5 Tempered Welded Fiber

Tempered welded fiber shall be exploded wood fibers and natural lining binding agent compressed into dense homogeneous sheets. Sheets are impregnated with a special tempering compound polymerized by baking to give exceptional strength.

### 2.1.6 High Pressure Plastic Laminate

Class I, Pub. No. LD-1-1971 NEMA. Laminate must meet the following requirements: Abrasion Resistance (NEMA Test #LD1.2.01) 400 cycles to wear 50 percent of pattern. Color fastness (NEMA Test #LD1-2.06). No crazing or change in surface texture or color when tested. No evidence of burns or discoloration noted when a burning cigarette was left on surface for 100 seconds. Stain resistance (NEMA Test #LD1-2.05). High resistance to stains and moisture absorption.

## 2.2 CABINetry SYSTEMS AND CONSTRUCTION

### 2.2.1 Concept II (Overlay) Design

Construction shall include all applicable requirements set forth in Paragraph 2.2 Cabinetry. The following material specification for exposed ends, unexposed ends, and vertical partition shall apply:

#### 2.2.1.1 Base Units

Base units shall be designed with solid ends and backs and fully enclosed toe space, protecting all interiors against dust and vermin. End panels shall be 3/4 inch plywood with front exposed edges of panels faced with solid hardwood. End panels shall be glued to horizontal frame units and to solid bottom panels. Jointery utilizing blind mortise and tenon, multiple dowel or stopped tongue and groove shall be acceptable. Backs shall be 1/4 inch hardwood plywood, grooved into end panels. Where access to plumbing is required, cupboard backs are to be removable. Cupboard bottoms shall be 3/4 inch hardwood plywood with exposed edge faced with solid hardwood providing a flush interior for ease of cleaning. Lock security panels shall be 3/16 inch tempered welded fiber fitting into an integral groove within the intermediate frame units. Shelves shall be half-width, adjustable, and made of 3/4 inch plywood with exposed edge faced with solid hardwood. All toe spaces shall be 2-1/2 inch deep and 4-1/4 inch high,

fully enclosed and an integral part of the case. Horizontal frame member sizes are as follows:

Top Horizontal:	Front & Rear	2-1/2" x 1-1/4" hardwood
	Side	1-1/4" x 1-1/4" hardwood
	Center	1-1/4" x 1-1/4" hardwood
Intermed. Horizontal:	Front & Rear	2-1/2" x 3/4" hardwood
	Side	1-1/4" x 3/4" hardwood
	Center	3-1/4" x 3/4" hardwood
Bottom:	Bottom to be 3/4" hardwood plywood with exposed edge faced with solid hardwood providing a flush interior.	

#### 2.2.1.2 Wall Cases

Wall cases shall be integrally constructed to provide a fully enclosed unit designed to ensure a dust and vermin-free interior. End panels shall be 3/4 inch plywood with exposed edges faced with solid hardwood. Tops and bottoms shall be one inch plywood with exposed front edges faced with hardwood. End panels shall be glued to top and bottom panels through blind mortise and tenon or doweled joints. Further reinforcement through screws, cleats, hot glue and stapled pins shall be provided as required. Backs shall be 1/4 inch hardwood plywood grooved into end and bottom panels and further secured through the use of glue and unexposed top and bottom back rails. The interior of the case shall be completely flush for ease of cleaning. Shelves shall be one inch plywood with front edge faced with solid hardwood, fully adjustable. Wall cases in Room C200 shall have all exposed wood surfaces and edges faced with plastic laminate.

#### 2.2.1.3 Doors

Doors shall be 3/4 inch thick, five-ply lumber core with hardwood veneer faces or 13/16 inch thick particleboard core. Doors shall be laminated with plastic laminate both faces. Edges shall be faced with black extruded PVC, adhesively applied. Use of a non-resilient edge shall not be permitted. Door corners shall be radiused not less than 3/8 inch and edging shall be a single strip, continuously wrapped with a single joint only. Swinging doors to 48 inches high shall be hinged with two hinges per door.

#### 2.2.1.4 Drawer Fronts

Drawer fronts shall be 3/4 inch thick, five-ply lumber core with hardwood veneer faces or 13/16 inches thick particleboard core. Drawer fronts shall be laminated with plastic laminate both faces. Edges shall be faced with black extruded PVC adhesively applied. Use of a non-resilient edge shall not be permitted. Drawer front corners shall be radiused not less than 3/8 inch and edging shall be a single strip, continuously wrapped with a single joint only. Drawer fronts shall be attached to drawer boxes with screws. Sides, backs, and fronts of drawer boxes shall be 7/16 inch laminated hardwood. Drawer box fronts shall be dovetailed and glued to side members. Back members of drawer boxes shall be dadoed into the side members, glued and pinned. Bottoms shall be 3/16 inch tempered welded fiber grooved into box front, back and sides. Drawer bottoms shall be further secured with hot glue flowed into the bottom retention groove from the underside thus forming a rigid and a unitized drawer box.

## 2.3 SECURITY PANEL

Shall be of 3/16 composition board set in groove in intermediate frame. security panel provided between drawers and/or drawers and doors when base cabinet is to have locks. Pulls for drawers and doors shall be of a clean, modern design offering a comfortable hand grip, and shall attach to drawer or door with machine screws on 4 inch centers. Pulls shall be of extruded aluminum with satin lacquer finish.

## 2.4 DRAWERS

### 2.4.1 Drawer Runners

Embossed and formed 20 gauge steel channel shaped to accommodate sheet ball bearings rollers with nylon wheels and shall interlock into side tracks on cabinets. Runners have instant removal stop to prevent inadvertent removal, and positive closing action. Runners shall be heavy duty type and shall have minimum load capacity of 75 pounds per pair, based on 18 inch slide length. Single doors shall be locked to case sides. Hinges shall be five-knuckle institutional type heavy-duty hinges with wrap-around door wings. Hinges shall be 2-3/4 inch steel with satin black finish. Hinges are to be mounted to door and case with not less than three screws per wing.

## 2.5 SHELVING WITHIN CABINETS

### 2.5.1 Panel

3/4 inch thick uniform close grained oak veneer, 7-ply half-round cut with 1/28 inch face to meet National Bureau of Standards specification PS 51-71 for "Sound Grade 2" on both sides. Front edge to be machined to accept a front nose tenon of 1-1/2 inch by 3/4 inch select solid oak hardwood. Shelf shall be notched on bottom to avoid shelf slippage from adjustable clips.

### 2.5.2 Attachment

Hardwood nose banding shall be applied to plywood edges using manufacturers standard water resistant resin glue.

### 2.5.3 Adjustability

On 1/2 inch centers, supported by four metal shelf clips. Shelf uprights zinc plated steel, perforated for adjustable clips. In lieu of recessed shelf standards, adjustability may be obtained by one of the following methods:

- a. Double peg plastic clips in pre-drilled holes. Each clip shall have two pegs (one peg above the shelf and one peg below the shelf). The clips shall have slots for the shelving (to hold the shelving in place).
- b. Single peg zinc plated steel clips in pre-drilled holes. The underside of the shelving shall be rabbeted to receive the clips (to hold the shelving in place).

## 2.6 HARDWARE

### 2.6.1 Catches

Catches shall be provided on swinging doors and shall be a spring-loaded nylon roller type.

#### 2.6.2 Elbow Catches

Elbow catches shall be used on left-hand doors where required for latching security when doors are to be locked. Elbow catches shall be steel, zinc plated.

#### 2.6.3 Locks

Locks shall be furnished for all doors and drawers. Locks for all doors shall be laboratory grade with minimum 8 tumblers. Lock action shall be cam type without use of spring action, masterkeyed and furnished with two keys per lock. One master key systems shall be provided. Five (5) tumbler laboratory grade locks shall be acceptable in lieu of 8 tumbler locks providing the locks comply with the physical and functional requirements of this paragraph.

Keying system shall be provided as follows:

- a. All locks within each room shall be keyed alike and all break rooms keyed alike. The Security Office shall be keyed different.

#### 2.6.4 Drawer Stops

Drawer stops shall be provided on all drawers to prevent in-advertent removal. Stops shall be automatic type, zinc plated steel.

#### 2.6.5 Plastic Grommets

Provide two inch diameter I.D. plastic grommets for wire feeds through countertops (8 total) at Security Office, locate and place grommets as directed by Contracting Officer.

#### 2.6.6 Undercounter Keyboard Drawer

Three undercounter keyboard drawers shall be provided, locate and place as directed by the Contracting Officer. Drawers shall be undercounter mounted to store keyboard and swivel mouse platform. Tray shall extend 11-1/4 inches to fully expose a keyboard. Keyboard is not in contract. Mouse platform shall install for right or left handed use. Undercounter keyboard drawer dimensions are 22-1/2 inches wide by 13-3/4 inches deep.

#### 2.6.7 Structural Tube Frames

Structural tube frames to support countertops and vanities shall be fabricated of 1-1/2 inch by 1-1/2 inch by 12 gauge structural steel tubing.

All joints shall be fully welded to produce a unitized support. Welds shall be lightly ground and brushed. Finish of tube frames shall be as indicated. Frames shall be anchored to supporting walls as indicated.

### 2.7 FABRICATION

#### 2.7.1 Fabricate

Fabricate casework to dimensions, profiles, and details shown or described in equipment list and contract drawings.

### 2.7.2 Assemble

Assemble units in the shop in as large components as practical to minimize field cutting and jointing. Mortise and tenon, glue and screw joints for maximum strength using precision jigs and clamps to insure square corners and plumb vertical surfaces.

### 2.8 COUNTERTOPS

Solid polymer countertops are specified in Section 06650.

### 2.9 CASEWORK FINISH

All exteriors and exposed surfaces to receive finish shall be free of machine marks, carefully and smoothly sanded in preparation for finishing. Exteriors except for exposed casework framing, inside surfaces of doors shall be plastic laminate finished. Cupboard interiors and shelves shall then be stained, followed by resinous sealer, dried properly and carefully sanded. Two coats of chemical resistant catalyzed synthetic alkyd-urea resin varnish shall then be applied and thoroughly dried, resulting in a smooth semi-gloss finish. Drawer boxes shall receive the same finish except that the stain may be omitted. Bottoms, unexposed backs and ends shall be sealed with pigmented resinous sealer. Top frames, interior of drawer openings and toe eases shall be sealed with clear sealer.

Laboratory grade finish test for wood finishes according to SAMA minimum standards:

#### 2.9.1 Chemical Reagent Test

##### MOISTURE RESISTANCE TESTS

One Hundred Hour Contact	A
Boiling Water (five Minute contact)	A

##### IMPACT RESISTANCE TEST

There were no cracks or crazing in the finish film when an 18 inch crossbar 3/4 inch in diameter weighing one pound was dropped onto the finished surface from a height of 36 inches. The only cracks in the coating were where the wood support cracked. There was still good adhesion of the coating to the wood along the edges of the cracks.

##### FADE/ULTRAVIOLET RESISTANCE TEST

The coating was darkened only very slightly by exposure to a sunlamp at a distance of one foot for 100 hours.

##### COMBUSTIBILITY TEST

A small pool (approximately 0.5 ml) of naphtha was ignited and allowed to burn itself out on the finished surface. No effect to the surface was noted.

## PART 3 EXECUTION

### 3.1 GENERAL CASEWORK AND FURNISHINGS INSTALLATION

#### 3.1.1 General

Install, plumb, level, true and straight with no distortions. Shim as required, using concealed shims. Where casework abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.

### 3.1.2 Base Cabinets

Set cabinets, straight, plumb and level. Adjust sub-tops within 1/16 inch of a single plane. Fasten adjoining cabinets together. Secure cabinets to floor and walls as required to provide a secure and solid anchorage of all units.

Where required assemble units into one integral unit with joints flush, tight and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.

### 3.1.3 Wall Cabinets

Securely fasten to solid supporting material, not plaster, lath or wallboard. Anchor, adjust and align wall cabinets as specified for base cabinets.

### 3.1.4 Shelving

Set shelving straight plumb and level. Secure shelving to walls, floors and/or other individual units as recommended by manufacturer. Where required, assemble shelves into one integral unit with joint flush tight and uniform.

### 3.1.5 Casework and Hardware

Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

## 3.2 INSTALLATION OF TOPS

### 3.2.1 Field Jointing

Where practicable, make in same manner as factory jointing using dowels, splines, adhesives and fasteners recommended by manufacturer. Locate field joints as shown on accepted shop drawings, factory prepared so there is no job site processing of top and edge surfaces.

### 3.2.2 Fastenings

Use concealed clamping devices for field joints, located within 6 inch of front, at back edges and at intervals not exceeding 24 inch. Tighten in accordance with manufacturer's instructions to exert a constant, heavy clamping pressure at joints. Secure tops to cabinets with "Z" type fasteners or equivalent, using 2 or more fasteners at each front, end and back.

### 3.2.3 Workmanship

Abut top and edge surfaces in open true plane, with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices.

After installation, carefully dress joints smooth, remove any surface scratches, clean and polish entire surface.

#### 3.2.4 Holes and Cutouts

Provide holes and cutouts as required for plumbing, mechanical, and electrical service fixtures.

#### 3.2.5 Scribe Moldings

Provide scribe moldings for closures at junctures of top, curb and splash with walls as recommended by manufacturer for materials involved. Use chemical resistant, permanently elastic sealing compound where recommended by manufacturer.

### 3.3 INSTALLATION OF ACCESSORIES

Install in a precise manner in accordance with manufacturer's directions. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely without excessive bind.

### 3.4 CLEANING AND PROTECTION

Repair or remove and replace defective work as directed upon completion of installation.

Clean shop-finished surface, touch-up as required, and remove or refinish damaged or soiled areas.

#### 3.4.1 Protection

Advise Contractor of procedures and precautions for protection of materials and installed shelving and casework from damage by work of other trades.

-- End of Section --

## SECTION 12490A

WINDOW TREATMENT  
01/98

## PART 1 WORK DESCRIPTION

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-V-00200

(Rev B) Venetian Blinds

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Approved Detail Drawings

Drawings showing fabrication and installation details. Drawings shall show layout and locations of track, direction of draw, mounting heights, and details.

## SD-03 Product Data

Window Treatments  
Hardware

Manufacturer's data composed of catalog cuts, brochures, product information, and maintenance instructions.

## SD-04 Samples

## Window Treatments; G

Three samples of each type and color of window treatment. Blind slats or louvers shall be 6 inches in length for each color. Track shall be 6 inches in length. Shade material shall be minimum 6 x 6 inches in size.

## 1.3 GENERAL

Window treatment shall be provided, complete with necessary brackets, fittings, and hardware. Each window treatment type shall be a complete unit provided in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Equipment shall be mounted and operated as indicated. Windows to receive a treatment shall be completely covered. The Contractor shall

take measurements at the building and shall be responsible for the proper fitting and hanging of the equipment.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated and free from dust, water, or other contaminants and shall have easy access for inspection and handling. Materials shall be stored flat in a clean dry area with temperature maintained above 50 degrees F.

#### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

### PART 2 PRODUCTS

#### 2.1 WINDOW BLINDS

Each blind, including hardware, accessory items, mounting brackets and fastenings, shall be provided as a complete unit produced by one manufacturer. All parts shall be one color unless otherwise shown, and match the color of the blind slat. Steel features shall be treated for corrosion resistance.

##### 2.1.1 Horizontal Blinds

Horizontal blinds shall conform to FS AA-V-00200, Type II ( 1 inch slats), except as modified below. Blind units shall be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds shall be inside (within cased opening) mount as shown.

##### 2.1.1.1 Head Channel and Slats

Head channel shall be steel or aluminum nominal 0.024 for Type II. Slats shall be aluminum, not less than 0.008 inch thick, and of sufficient strength to prevent sag or bow in the finished blind. A sufficient amount of slats shall be provided to assure proper control, uniform spacing, and adequate overlap.

##### 2.1.1.2 Controls

The slats shall be tilted by a transparent tilting wand, hung vertically by its own weight, and shall swivel for easy operation. The tilter control shall be of enclosed construction. Moving parts and mechanical drive shall be made of compatible materials which do not require lubrication during normal expected life. The tilter shall tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. A mechanism shall be included to prevent over tightening. The wand shall be

of sufficient length to reach to within 5 feet of the floor.

#### 2.1.1.3 Intermediate Brackets

Intermediate brackets shall be provided for installation of blinds over 48 inches wide and shall be installed as recommended by the manufacturer.

#### 2.1.1.4 Hold-Down Brackets

Universal type hold-down brackets for sill or jamb mount shall be provided.

### 2.2 COLOR

Color shall be as indicated.

## PART 3 EXECUTION

### 3.1 WINDOW TREATMENT PLACEMENT SCHEDULE

Window covering shall be provided for all exterior windows except at Rooms A100, D100, and within stairwells. Window coverings shall be provided for interior windows of Rooms A213, A212, D201, and D202.

### 3.2 INSTALLATION

Installation shall be in accordance with the approved detail drawings and manufacturer's installation instructions. Units shall be level, plumb, secure, and at proper height and location relative to window units. The Contractor shall furnish and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Installation shall not be initiated until completion of room painting and finishing operations. Upon completion of the installation, window treatments shall be adjusted for form and appearance, shall be in proper operating condition, and shall be free from damage or blemishes. Damaged units shall be repaired or replaced by the Contractor as directed by the Contracting Officer.

-- End of Section --

## SECTION 13100

LIGHTNING PROTECTION SYSTEM  
07/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.30 (1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 780 (1997) Installation of Lightning Protection Systems

## UNDERWRITERS LABORATORIES (UL)

UL 96 (1994; Rev thru Jan 2000) Lightning Protection Components

UL 96A (1994; Rev thru Jul 1998) Installation Requirements for Lightning Protection Systems

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL Elec Const Dir (1999) Electrical Construction Equipment Directory

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

## 1.2.2 System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved design. The lightning protection system shall conform to NFPA 70 and NFPA 780, UL 96 and UL 96A, except where requirements in excess thereof are specified herein. The lightning protection system shall comply with UL for

master labelled system, be inspected by a certified UL inspector and be certified as a U.L. Master Label System.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Drawings; G, AO

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

#### SD-07 Certificates

Materials; G, AO

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in UL Elec Const Dir will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted. A letter of findings shall be submitted certifying UL inspection of lightning protection systems provided on the following facilities: Operations Support Center building.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

#### 2.1.2 Main and Secondary Conductors

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.

#### 2.1.2.1 Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than No. 4/0 AWG.

#### 2.1.2.2 Aluminum

Aluminum shall not contact the earth nor shall it be used in any other manner that will contribute to rapid deterioration of the metal. Appropriate precautions shall be observed at connections with dissimilar metals. Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least equivalent to strength and cross-sectional area of a No. 4 AWG aluminum wire. When perforated strips are provided, strips that are much wider than solid strips shall be. A strip width that is at least twice that of the diameter of the perforations shall be used. Aluminum strip for connecting exposed water pipes shall be not less than No. 12 AWG in thickness and at least 1-1/2 inches wide.

#### 2.1.3 Air Terminals

Terminals shall be in accordance with UL 96 and NFPA 780. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides not less than one-half the height of the terminal.

#### 2.1.4 Ground Rods

Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to ANSI C135.30. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length. Ground rods of copper-clad steel, stainless steel, galvanized ferrous, and solid copper shall not be mixed on the job.

#### 2.1.5 Connectors

Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation.

#### 2.1.6 Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, chimney bands, clips, and fasteners shall conform to UL 96, classes as applicable.

### PART 3 EXECUTION

#### 3.1 INTEGRAL SYSTEM

##### 3.1.1 General Requirements

The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, associated appurtenances and grounds, electrically interconnected to form the shortest distance to ground. All conductors on the structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls and as indicated. Secondary conductors shall interconnect with grounded metallic

parts within the building. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

#### 3.1.1.1 Air Terminals

Air terminal design and support shall be in accordance with NFPA 780. Terminals shall be rigidly connected to, and made electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal and connected to the air terminal by a dowel or threaded fitting. Air terminals at the ends of the structure shall be set not more than 2 feet from the ends of the ridge or edges and corners of roofs. Spacing of air terminals 2 feet in height on ridges, parapets, and around the perimeter of buildings with flat roofs shall not exceed 25 feet.

In specific instances where it is necessary to exceed this spacing, the specified height of air terminals shall be increased not less than 2 inches for each foot of increase over 25 feet. On large, flat or gently sloping roofs, as defined in NFPA 780, air terminals shall be placed at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Metal projections and metal parts of buildings, and other metal objects that do not contain hazardous materials and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals. However, these metal objects shall be bonded to the lightning conductor through a metal conductor of the same unit weight per length as the main conductor. Where metal ventilators are installed, air terminals shall be mounted thereon, where practicable. Any air terminal erected by necessity adjacent to a metal ventilator shall be bonded to the ventilator near the top and bottom.

Where metal ventilators are installed with air terminals mounted thereon, the air terminal shall not be more than 24 inches away from the farther edge or corner. If the air terminal is farther than this distance, an additional air terminal shall be added in order to meet this requirement. Where metal ventilators are installed with air terminals mounted adjacent, the air terminal shall not be more than 24 inches away from the farther edge or corner. If the air terminal is farther than this distance, an additional air terminal shall be added in order to meet this requirement.

#### 3.1.1.2 Roof Conductors

Roof conductors shall be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns shall have a radius of not less than 8 inches. Conductors shall preserve a downward or horizontal course and shall be rigidly fastened every 3 feet along the roof and down the building to ground. Metal ventilators shall be rigidly connected to the roof conductor at three places. All connections shall be electrically continuous. Roof conductors shall be coursed along the contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest. Roof conductors surrounding tank tops, decks, flat surfaces, and flat roofs shall be connected to form a closed loop.

#### 3.1.1.3 Down Conductors

Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes. Down conductors shall be coursed over extreme outer portions of the building, such as corners, with consideration given to the location of ground connections and air

terminals. Each building or structure shall have not less than two down conductors located as widely separated as practicable, at diagonally opposite corners. On rectangular structures having gable, hip, or gambrel roofs more than 110 feet long, there shall be at least one additional down conductor for each additional 50 feet of length or fraction thereof. On rectangular structures having French, flat, or sawtooth roofs exceeding 250 feet in perimeter, there shall be at least one additional down conductor for each 100 feet of perimeter or fraction thereof. On irregularly shaped structures, the total number of down conductors shall be sufficient to make the average distance between them along the perimeter not greater than 100 feet. On structures exceeding 50 feet in height, there shall be at least one additional down conductor for each additional 60 feet of height or fraction thereof, except that this application shall not cause down conductors to be placed about the perimeter of the structure at intervals of less than 50 feet. Additional down conductors shall be installed when necessary to avoid "dead ends" or branch conductors ending at air terminals, except where the air terminal is on a roof below the main protected level and the "dead end" or branch conductor is less than 16 feet in length and maintains a horizontal or downward coursing. Down conductors shall be equally and symmetrically spaced about the perimeter of the structure. Down conductors shall be protected by placing in conduit as indicated.

#### 3.1.1.4 Interconnection of Metallic Parts

Metal doors, windows, and gutters shall be connected directly to the grounds or down conductors using not smaller than No. 6 copper conductor, or equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected. The ground connection to metal doors and windows shall be by means of mechanical ties under pressure, or equivalent.

#### 3.1.1.5 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

#### 3.1.1.6 Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 3 feet, nor more than 8 feet, from the structures foundation. The complete installation shall have a total resistance to ground of not more than 1 ohms if a counterpoise is not used. Ground rods shall be tested individually prior to connection to the system and the system as a whole shall be tested not less than 48 hours after rainfall. When the resistance of the complete installation exceeds the specified value or two ground rods individually exceed 5 ohms, the Contracting Officer shall be notified immediately. A

counterpoise, where required, shall be of No. 4/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet deep at a distance not less than 3 feet nor more than 8 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous. Where so indicated on the drawings, an alternate method for grounding electrodes in shallow soil shall be provided by digging trenches radially from the building. The lower ends of the down conductors are then buried in the trenches.

### 3.1.2 Metal Roofs

Wood-Frame, Wall-Bearing Masonry or Tile Structure with Metallic Roof and Nonmetallic Exterior Walls, or Reinforced Concrete Building with Metallic Roof: Metal roofs which are in the form of sections insulated from each other shall be made electrically continuous by bonding. Air terminals shall be connected to, and made electrically continuous with, the metal roof as well as the roof conductors and down conductors. Ridge cables and roof conductors shall be bonded to the roof at the upper and lower edges of the roof and at intervals not to exceed 100 feet. The down conductors shall be bonded to roof conductors and to the lower edge of the metal roof.

Where the metal of the roof is in small sections, the air terminals and down conductors shall have connections made to at least four of the sections. All connections shall have electrical continuity and have a surface contact of at least 3 square inches.

### 3.1.3 Metal Roofs With Metal Walls

Wood-Frame Building With Metal Roof and Metal Exterior Walls: The metal roof and the metal walls shall be bonded and made electrically continuous and considered as one unit. The air terminals shall be connected to and made electrically continuous with the metal roof as well as the roof and down conductors. All connections shall have electrical continuity and have a surface contact of at least 3 square inches.

### 3.1.4 Steel Frame Building

The steel framework shall be made electrically continuous. Electrical continuity may be provided by bolting, riveting, or welding steel frame, unless a specific method is noted on the drawings. The air terminals shall be connected to the structural steel framework at the ridge. Short runs of conductors shall be used as necessary to join air terminals to the metal framework so that proper placing of air terminals is maintained. Separate down conductors from air terminals to ground connections are not required. Where a grounded metal pipe water system enters the building, the structural steel framework and the water system shall be connected at the point of entrance by a ground connector. Connections to pipes shall be by means of ground clamps with lugs. Connections to structural framework shall be by means of nut and bolt or welding. All connections between columns and ground connections shall be made at the bottom of the steel columns. Ground connections to grounding electrodes or counterpoise shall be run from not less than one-half of all the columns distributed equally around the perimeter of the structure at intervals averaging not more than 60 feet.

### 3.1.5 Post Tensioning Systems

On construction utilizing post tensioning systems to secure precast

concrete sections, the post tension rods shall not be used as a path for lightning to ground. Down conductors shall be provided on structures using post tensioning systems; down conductors shall have sufficient separation from post tension rods to prevent side-flashing. Post tension rods shall be bonded to the lightning protection and grounding systems only at the base of the structure; this bonding shall be performed in strict accordance with the recommendations of the post tension rod manufacturer, and shall be done by, or in the presence of, a representative of the manufacturer.

### 3.2 INTERCONNECTION OF METAL BODIES

Metal bodies of conductance shall be protected if not within the zone of protection of an air terminal. Metal bodies of conductance having an area of 400 square inches or greater or a volume of 1000 cubic inches or greater shall be bonded to the lightning protection system using main size conductors and a bonding plate having a surface contact area of not less than 3 square inches. Provisions shall be made to guard against the corrosive effect of bonding dissimilar metals. Metal bodies of inductance shall be bonded at their closest point to the lightning protection system using secondary bonding conductors and fittings. A metal body that exceeds 5 feet in any dimension, that is situated wholly within a building, and that does not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

### 3.3 INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

-- End of Section --

## SECTION 13210

## ABOVEGROUND FUEL OIL STORAGE TANKS

**2/02**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.26 (1988) Cast Copper Alloy Fittings for Flared Copper Tubes

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1997; Rev. A) Carbon Structural Steel

ASTM A 569/A 569M (1998) Commercial Steel (CS) Sheet and Strip, Carbon (0.15 Maximum, Percent), Hot-Rolled

ASTM B 88 (1999) Seamless Copper Water Tube

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY, INC. (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30 (1996) Flammable and Combustible Liquids Code

NFPA 30A (1996) Automotive and Marine Service Station Code

NFPA 70 (2002) National Electrical Code

## UNDERWRITERS LABORATORIES INC. (UL)

UL 142 (1993) Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 674	(1994; Bul. 1996, R 1997) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 698	(1995; R 1996) Industrial Control Equipment for Use in Hazardous (Classified) Locations
UL 886	(1994; Bul. 1996, R 1997) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 2085	(1997) Protected Aboveground Tanks for Flammable and Combustible Liquids

## 1.2 SYSTEM DESCRIPTION

Provide aboveground storage tank systems and fuel piping systems complete and ready for operation. Fuel piping systems shall include aboveground piping, and connections to existing piping systems.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Aboveground storage tanks (AST) G.

Submit shop drawings for each size of AST for approval. Indicate types, sizes, locations, installation details, and other construction details.

### SD-03 Product Data

Aboveground storage tanks (AST) G, AE.

Leak Detection System G, AE.

High level alarm system G, AE.

Tank Level Gage System G, AE.

Alarm Control Panel System G, AE.

Remote alarm system G, AE.

### SD-06 Test Reports

Field acceptance test G, AE.

### SD-08 Manufacturer's Instructions

Installation instructions

## SD-10 Operation and Maintenance Data

Aboveground storage tanks(AST), Data Package 2 G, AE.

Alarm control panel system, Data Package 2 G, AE.

Accessories for AST's, Data Package 2 G, AE.

Submit in accordance with Section 01781N, "Operation and Maintenance Data".

## 1.4 DELIVERY AND STORAGE

Handle and store aboveground storage tanks and containment piping systems, to prevent distortions and other damage that could affect their structural, mechanical, or electrical integrity. Replace damaged items that cannot be restored to original condition. Store items subject to deterioration by exposure to elements, in a well-drained location, protected from weather, and accessible for inspection and handling.

## PART 2 PRODUCTS

## 2.1 ABOVEGROUND STORAGE TANKS (AST)

Tanks provided shall be either of the two specified tank types. Each provided AST shall be UL listed for compliance with UL 2085, as an insulated, secondary containment aboveground storage tank, protected type. Each tank shall bear the UL label in compliance with UL 2085.

## 2.1.1 Concrete Vaulted Tank

- a. Tank System: tank, thermal protection, secondary containment, and its enclosure (concrete vault) shall be shipped as a completed unit, that is, completely fabricated in manufacturer's factory.
- b. Primary Tank: Listed under UL 142; in compliance with NFPA 30; ASTM A 569/A 569M or ASTM A 36/A 36M carbon steel; warranted for a minimum of 20 years by the manufacturer.
- c. Concrete Vault: Minimum 6 inches thick; minimum design strength of 4000 psi at 28 days; encases and protects both primary and secondary containment; steel re-inforcing bars; vault shall be either monolithic, or be provided with one horizontal joint or seam for the removeable top of vault. No vertical joints or seams will be allowed.
- d. Corrosion Protection: Coating on steel components exterior to the concrete encasement shall meet requirements of ASTM B 117
- e. Spill and Overfill Containment: UL listed 7 gallon spill/overfill container manufactured as an integral part of the primary tank, surrounding the fill tube and protected by the 2 hour fire rating of the encasement; container shall have a stick port and normally closed valve to release spilled fluid into primary tank.
- f. Overspill Protection: One or more of the following methods:
  - (1) Direct reading level gauge visible from the fill pipe access.

- (2) Audible and visible high level alarm.
- g. Exterior Finish: Exposed aggregate with cementitious sealer, or vault surface sealed with cementitious sealer and then coated with gloss urethane finish coat..
- h. Signage: Signage shall be recessed in exterior of concrete to ensure against damage.
- i. Venting: NFPA 30; 2 inch atmospheric vent and emergency vent.
- j. Anti-spill Valves: Where product piping extends below the top of the primary tank, piping shall include shutoff valve and a normally closed safety valve; safety valve shall be an approved anti-siphon valve or an electric solenoid valve.

#### 2.1.2 Double-wall Steel Tank, Concrete Insulated

- a. Primary tank, its outer steel tank (outer enclosure), interstitial insulation, and the exterior fiberglass coating, all shall be shipped as a completed unit, that is, completely constructed in manufacturer's factory.
- b. Primary Tank and Outer Steel Tank: Listed under UL 142; in compliance with NFPA 30; ASTM A 569/A 569M or ASTM A 36/A 36M carbon steel; warranted for a minimum of 20 years by the manufacturer.
- c. Interstitial Insulation (Concrete): Concrete bounded by primary steel tank and outer steel tank; encases and protects primary tank; concrete placement shall be monolithic, that is, without seams; tank system provides the support legs which provide minimum of 3 inch clearance under outer tank.
- d. Corrosion Protection: Provide a fiberglass impregnated cladding on the exterior surface of the outer tank. This cladding shall be factory applied in the tank manufacturer's factory or an in factory acceptable to the tank manufacturer. The cladding shall be provided to a minimum thickness of 1/8 inch in compliance with the instructions of the cladding system manufacturer.
- e. Secondary Containment: Outer steel tank.
- f. Spill and Overfill Containment: UL listed 7 gallon spill/overfill container manufactured as an integral part of the primary tank, surrounding the fill tube and protected by the 2 hour fire rating of the encasement; container shall have a stick port and normally closed valve to release spilled fluid into primary tank.
- g. Overspill Protection: One or more of the following methods: (a) direct reading level gauge visible from the fill pipe access, (b) audible and visible high level alarm.
- h. Venting: NFPA 30; 2 inch atmospheric vent and emergency vent.
- i. Anti-spill Valves: Where product piping extends below the top of the primary tank, piping shall include shutoff valve and a normally closed safety valve; safety valve shall be an approved anti-siphon valve or an electric solenoid valve.

- j. Outer Steel Tank Exterior Finish: manufacturer's fiberglass impregnated coating with total dry thickness a minimum of 1/8 inch thick.

## 2.2 ACCESSORIES FOR AST's

Provide the following accessories coordinated with each tank design: Leak detection sensor, high level alarm switch, fill port with overflow spill box, fuel outlet with anti-siphon foot valve, leak detection sensor, and vent with whistle alarm.

### 2.2.1 Leak Detection System

Provide continuous surveillance probe type leak detection system. System shall be suitable for operation in NFPA 70, Class 1, Group D environment. Locate the leak detection system in the leak containment space between the primary tank and the secondary containment. Leak detection system shall electronically detect fluid leakage into containment space.

Sensor output and transmission shall be electronic. Probe mounting system shall not restrict the flow of liquid to the sensing area of the probes. Sensor output shall provide control signal to the alarm control panel system specified in this section.

Probe configuration shall be brass or stainless steel components with BUNA-N float. System shall give alarm condition when no more than 1/2 inch of liquid leakage is present.

### 2.2.2 High Level Alarm System

Provide each tank with a vertical float type high level switch with alarm setting at 95 percent tank capacity. Switch output shall provide control signal to the alarm control panel system specified in this section.

### 2.2.3 Tank Level Gage System

Provide tank manufacturer's standard cataloged level gage system

### 2.2.4 [Enter Appropriate Subpart Title Here]2.2.4.1 Controller For Automatic Operation

- a. Level transmitter for installation in 2 inch tank fitting.
- b. 90 percent tank level visual alarm.
- c. 95 percent tank level visual alarm.
- d. Tank leak alarm.
- e. Audible alarm horn activated by alarms specified above.
- f. Power available indicator.
- g. Control power on-off switch.
- h. Pump start/stop push-buttons.
- i. top-off/hose drain mode push-button.

- j. Pump starter.
- k. Explosion proof controller enclosure.

## 2.3 PIPING SYSTEMS

### 2.3.1 Copper Tubing System

Provide ASTM B 88, Type K or Type L copper tubing with ASME B16.26 flared fittings or compression type fittings for fuel oil supply, fuel oil return, and secondary (controls) piping.

### 2.3.2 Gate Valves

MSS SP-80, Class 125.

### 2.3.3 Check Valves

MSS SP-80, Class 125, swing check.

### 2.3.4 Pipe Hangers and Supports

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Indicated hangers which do are not covered by MSS SP-69 configurations, shall meet the applicable design requirements of MSS SP-58, and the hanger spacing requirements of MSS SP-69. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor.

### 2.3.5 Dielectric Connections

Provide dielectric connections at piping connections of dissimilar metals.

## 2.4 ELECTRICAL REQUIREMENTS

Provide switches and devices necessary for the tank electrical systems system; wiring, fittings, and components shall be explosion-proof in compliance with applicable requirements of UL 674, UL 698, and UL 886 for Class I, Division 1, Group C and D hazardous locations. Electrical installations shall conform to requirements of NFPA 70.

### 2.4.1 Alarm Control Panel System

Control panel shall be in NEMA 4X enclosure, suitable for the environment, and the panel shall include solid state circuitry, and visual alarms. Locate each panel at indicated spot. Panel shall incorporate a manual, self-test system which permits verification of proper operation of high level alarm audible and visual alarm equipment. Provide a reset button to silence the audible alarm, but at the same time maintaining the lit alarm light until the alarm condition is corrected.

### 2.4.2 Remote Alarm System

System shall be in NEMA 4X enclosure, suitable for the environment, and

shall include an audible alarm. Locate each enclosure at indicated spot.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Fuel Storage Tanks

Install vault type fuel storage tanks, vents, and other connections in accordance with NFPA 30 and NFPA 30A and published installation instructions of the manufacturer.

#### 3.2 FIELD TESTING.

Prior to application of test pressure, remove or valve off piping components which may be damaged by test and install a calibrated test gage in the system. Maintain test pressure for at least one hour on all new piping work. In the event of leakage, locate and repair leak and repeat test. Submit a field acceptance test report for each new AST system installation and each new piping system installation.

##### 3.2.1 Piping System Test

After tank erection and installation of valves and piping, test piping. Perform hydrostatic test of new fuel piping work at 100 psig for one hour. Replace defective material disclosed by pressure test and repeat test until results are satisfactory.

##### 3.2.2 Storage Tank Test

Pressure test tanks at not less than 5 psig or more than 7 psig and as recommended by the manufacturer.

#### 3.3 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the AST system, accessories for the AST, and the associated piping system. Instruction shall be given during the a regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. Schedule instruction time with Contracting Officer. The number of man-days (8 hours per day) of instruction furnished shall be one. Use approximately half of the time for classroom instruction. Use other time for instruction in the field at the equipment or system.

-- End of Section --

## SECTION 13280A

ASBESTOS ABATEMENT  
11/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI Z87.1 (1989; Errata; Z87.1a) Occupational and Educational Eye and Face Protection
- ANSI Z88.2 (1992) Respiratory Protection
- ANSI Z9.2 (1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 732 (1995) Aging Effects of Artificial Weathering on Latex Sealants
- ASTM D 1331 (1989; R 1995) Surface and Interfacial Tension of Solutions of Surface-Active Agents
- ASTM D 4397 (1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
- ASTM E 119 (2000) Fire Tests of Building Construction and Materials
- ASTM E 1368 (2000) Visual Inspection of Asbestos Abatement Projects
- ASTM E 736 (1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
- ASTM E 84 (2000a) Surface Burning Characteristics of Building Materials
- ASTM E 96 (2000) Water Vapor Transmission of Materials

## COMPRESSED GAS ASSOCIATION (CGA)

- CGA G-7 (1990) Compressed Air for Human Respiration
- CGA G-7.1 (1997) Commodity Specification for Air

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701 (1999) Methods of Fire Tests for  
Flame-Resistant Textiles and Films

## NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH Pub No. 84-100 (1984; Supple 1985, 1987, 1988 & 1990)  
NIOSH Manual of Analytical Methods

## U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (1996) U.S. Army Corps of Engineers Safety  
and Health Requirements Manual

## U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018 (1990) Asbestos/NESHAP Regulated Asbestos  
Containing Materials Guidance

EPA 340/1-90/019 (1990) Asbestos/NESHAP Adequately Wet  
Guidance

EPA 560/5-85-024 (1985) Guidance for Controlling  
Asbestos-Containing Materials in Buildings

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1926 Safety and Health Regulations for  
Construction

40 CFR 61 National Emission Standards for Hazardous  
Air Pollutants

40 CFR 763 Asbestos

42 CFR 84 Approval of Respiratory Protective Devices

49 CFR 107 Hazardous Materials Program Procedures

49 CFR 171 General Information, Regulations, and  
Definitions

49 CFR 172 Hazardous Materials Table, Special  
Provisions, Hazardous Materials  
Communications, Emergency Response  
Information, and Training Requirements

49 CFR 173 Shippers - General Requirements for  
Shipments and Packagings

## UNDERWRITERS LABORATORIES (UL)

UL 586 (1996; Rev thru Aug 1999) High-Efficiency,  
Particulate, Air Filter Units

## 1.2 DEFINITIONS

- a. Adequately Wet: A term defined in 40 CFR 61, Subpart M, and EPA 340/1-90/019 meaning to sufficiently mix or penetrate with liquid to prevent the release of particulate. If visible emissions are observed coming from asbestos-containing material (ACM), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wetted.
- b. Aggressive Method: Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact asbestos-containing material (ACM).
- c. Amended Water: Water containing a wetting agent or surfactant with a surface tension of at least 29 dynes per square centimeter when tested in accordance with ASTM D 1331.
- d. Asbestos: Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered.
- e. Asbestos-Containing Material (ACM): Any materials containing more than one percent asbestos.
- f. Asbestos Fiber: A particulate form of asbestos, 5 micrometers or longer, with a length-to-width ratio of at least 3 to 1.
- g. Authorized Person: Any person authorized by the Contractor and required by work duties to be present in the regulated areas.
- h. Building Inspector: Individual who inspects buildings for asbestos and has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.
- i. Certified Industrial Hygienist (CIH): An Industrial Hygienist certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.
- j. Class I Asbestos Work: Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM.
- k. Class II Asbestos Work: Activities defined by OSHA involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos - containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glovebag may be classified as a Class III job.
- l. Class III Asbestos Work: Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is

actively disturbed or asbestos-containing debris is actively disturbed.

- m. Class IV Asbestos Work: Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction.
- n. Clean room: An uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.
- o. Competent Person: In addition to the definition in 29 CFR 1926, Section .32(f), a person who is capable of identifying existing asbestos hazards as defined in 29 CFR 1926, Section .1101, selecting the appropriate control strategy, has the authority to take prompt corrective measures to eliminate them and has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.
- p. Contractor/Supervisor: Individual who supervises asbestos abatement work and has EPA Model Accreditation Plan "Contractor/Supervisor" training; accreditation required by 40 CFR 763, Subpart E, Appendix C.
- q. Critical Barrier: One or more layers of plastic sealed over all openings into a regulated area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in a regulated area from migrating to an adjacent area.
- r. Decontamination Area: An enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.
- s. Demolition: The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.
- t. Disposal Bag: A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926, Section .1101, used for transporting asbestos waste from containment to disposal site.
- u. Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glovebag or waste bag, not larger than 60 inches in length and width in order to access a building component.
- v. Equipment Room or Area: An area adjacent to the regulated area used for the decontamination of employees and their equipment.
- w. Employee Exposure: That exposure to airborne asbestos that would occur if the employee were not using respiratory protective

equipment.

- x. Fiber: A fibrous particulate, 5 micrometers or longer, with a length to width ratio of at least 3 to 1.
- y. Friable ACM: A term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10 percent, as determined by a method other than point counting by PLM, the asbestos content is verified by point counting using PLM.
- z. Glovebag: Not more than a 60 by 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.
- aa. High-Efficiency Particulate Air (HEPA) Filter: A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.
- bb. Homogeneous Area: An area of surfacing material or thermal system insulation that is uniform in color and texture.
- cc. Industrial Hygienist: A professional qualified by education, training, and experience to anticipate, recognize, evaluate, and develop controls for occupational health hazards.
- dd. Intact: ACM which has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix. Removal of "intact" asphaltic, resinous, cementitious products does not render the ACM non-intact simply by being separated into smaller pieces.
- ee. Model Accreditation Plan (MAP): USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763, Subpart E, Appendix C.
- ff. Modification: A changed or altered procedure, material or component of a control system, which replaces a procedure, material or component of a required system.
- gg. Negative Exposure Assessment: A demonstration by the Contractor to show that employee exposure during an operation is expected to be consistently below the OSHA Permissible Exposure Limits (PELs).
- hh. NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.
- ii. Nonfriable ACM: A NESHAP term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material containing more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Subpart E, Appendix A, Section 1, Polarized Light Microscopy, that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

- jj. Nonfriable ACM (Category I): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy.
- kk. Nonfriable ACM (Category II): A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos, as determined using the methods specified in 40 CFR 763, Subpart F, Appendix A, Section 1, Polarized Light Microscopy, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
- ll. Permissible Exposure Limits (PELs):
- (1) PEL-Time weighted average(TWA): Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8 hour time weighted average (TWA), as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.
- (2) PEL-Excursion Limit: An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes as determined by the method prescribed in 29 CFR 1926, Section .1101, Appendix A, or the current version of NIOSH Pub No. 84-100 analytical method 7400.
- mm. Regulated Area: An OSHA term defined in 29 CFR 1926, Section .1101 meaning an area established by the Contractor to demarcate areas where Class I, II, and III asbestos work is conducted; also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.
- nn. Removal: All operations where ACM is taken out or stripped from structures or substrates, and includes demolition operations.
- pp. Spills/Emergency Cleanups: Cleanup of sizable amounts of asbestos waste and debris which has occurred, for example, when water damage occurs in a building, and sizable amounts of ACM are dislodged. A Competent Person evaluates the site and ACM to be handled, and based on the type, condition and extent of the dislodged material, classifies the cleanup as Class I, II, or III. Only if the material was intact and the cleanup involves mere contact of ACM, rather than disturbance, could there be a Class IV classification.
- rr. Thermal system insulation (TSI) ACM: ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.
- ss. Transite: A generic name for asbestos cement wallboard and pipe.

tt. Worker: Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926, Section .1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation required by 40 CFR 763, Subpart E, Appendix C, if required by the OSHA Class of work to be performed or by the state where the work is to be performed.

### 1.3 DESCRIPTION OF WORK

The work covered by this section includes the removal of asbestos-containing ceiling board, debris in attic and crawl space, thermal system insulation (boiler/tank insulation), and fibrous ducting, and demolition of Category I and II nonfriable asbestos containing materials which are encountered during demolition. This project is Intell OSC Campus (demolition of Buildings 18, 20, 21 and the bunker) located at Langley Air Force Base, Virginia. This section describes procedures and equipment required to protect workers of the regulated area from contact with airborne asbestos fibers and ACM dust and debris. Activities include OSHA Class I work operations involving ACM. The work also includes containment, storage, transportation and disposal of the generated ACM wastes. More specific operational procedures shall be detailed in the required Accident Prevention Plan and its subcomponents, the Asbestos Hazard Abatement Plan and Activity Hazard Analyses required in paragraph SAFETY AND HEALTH PROGRAM AND PLANS.

#### 1.3.1 Demolition of Buildings with Category I and II Nonfriable Asbestos Containing Materials

Category I and II nonfriable asbestos-containing materials (ACM) are present within the buildings. These materials include resilient floor coverings and associated mastics, asphaltic roofing materials, step tread, caulking materials and mastics, and transite board. The Contractor may elect to leave nonfriable ACM in place during demolition and dispose of the entire waste contents as nonfriable ACM in accordance with EPA NESHAP regulations (40 CFR 61). If the Contractor elects to follow this method, all procedures, monitoring, waste disposal, dust control measures, etc. shall be addressed within the asbestos removal plan. In addition, the Contractor will not be allowed to segregate/salvage waste materials, or compact debris for transport. Submit also certification that the landfill to be used for disposal has been notified and is willing to accept Category I and II nonfriable ACM.

#### 1.3.2 Abatement Work Tasks

The specific ACM to be abated is identified on the hazardous materials demolition drawings.

#### 1.3.3 Unexpected Discovery of Asbestos

For any previously untested building components suspected to contain asbestos and located in areas impacted by the work, the Contractor shall notify the Contracting Officer (CO) who will have the option of ordering up to ten bulk samples to be obtained at the Contractor's expense and delivered to a laboratory accredited under the National Institute of Standards and Technology (NIST) "National Voluntary Laboratory Accreditation Program (NVLAP)" and analyzed by PLM at no additional cost to the Government. Any additional components identified as ACM that have been approved by the Contracting Officer for removal shall be removed by the

Contractor and will be paid for by an equitable adjustment to the contract price under the CONTRACT CLAUSE titled "changes". Sampling activities undertaken to determine the presence of additional ACM shall be conducted by personnel who have successfully completed the EPA Model Accreditation Plan (MAP) "Building Inspector" training course required by 40 CFR 763, Subpart E, Appendix C.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

Respiratory Protection Program; G

Records of the respirator program.

Cleanup and Disposal; G

Waste shipment records. Weigh bills and delivery tickets shall be furnished for information only.

Materials and Equipment;

Manufacturer's catalog data for all materials and equipment to be used in the work, including brand name, model, capacity, performance characteristics and any other pertinent information. Material Safety Data Sheets for all chemicals to be used onsite in the same format as implemented in the Contractor's HAZARD COMMUNICATION PROGRAM. Data shall include, but shall not be limited to, the following items:

- a. High Efficiency Filtered Air (HEPA) local exhaust equipment
- b. Vacuum cleaning equipment
- c. Pressure differential monitor for HEPA local exhaust equipment
- d. Air monitoring equipment
- e. Respirators
- f. Personal protective clothing and equipment
  
- h. Duct Tape
- i. Disposal Containers
  - (1) Disposal bags

- j. Sheet Plastic
  - (1) Polyethylene Sheet - General
- k. Wetting Agent
  - (1) Amended Water
  - (2) Removal encapsulant
- l. Strippable Coating
- m. Prefabricated Decontamination Unit
- n. Other items
- o. Chemical encapsulant
  
- q. Material Safety Data Sheets (for all chemicals proposed)

Qualifications; G

A written report providing evidence of qualifications for personnel, facilities and equipment assigned to the work.

Training Program

A copy of the written project site-specific training material as indicated in 29 CFR 1926, Section.1101 that will be used to train onsite employees. The training document shall be signed by the Contractor's Designated IH and Competent Person.

Medical Requirements

Physician's written opinion.

Encapsulants; G

Certificates stating that encapsulants meet the applicable specified performance requirements.

SD-06 Test Reports

Exposure Assessment and Air Monitoring; G

Initial exposure assessments, negative exposure assessments, air-monitoring results and documentation.

Local Exhaust Ventilation

Pressure differential recordings.

Licenses, Permits and Notifications; G

Licenses, permits, and notifications.

#### SD-07 Certificates

##### Vacuum, Filtration and Ventilation Equipment

Manufacturer's certifications showing compliance with ANSI Z9.2 for:

- a. Vacuums.
- b. Water filtration equipment.
- c. Ventilation equipment.
- d. Other equipment required to contain airborne asbestos fibers.

### 1.5 QUALIFICATIONS

#### 1.5.1 Written Qualifications and Organization Report

The Contractor shall furnish a written qualifications and organization report providing evidence of qualifications of the Contractor, Contractor's Project Supervisor, Designated Competent Person, supervisors and workers; Designated IH (person assigned to project and firm name); independent testing laboratory (including name of firm, principal, and analysts who will perform analyses); all subcontractors to be used including disposal transportation and disposal facility firms, subcontractor supervisors, subcontractor workers; and any others assigned to perform asbestos abatement and support activities. The report shall include an organization chart showing the Contractor's staff organization for this project by name and title, chain of command and reporting relationship with all subcontractors. The report shall be signed by the Contractor, the Contractor's onsite project manager, Designated Competent Person, Designated IH, designated testing laboratory and the principals of all subcontractors to be used. The Contractor shall include the following statement in the report: "By signing this report I certify that the personnel I am responsible for during the course of this project fully understand the contents of 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and the federal, state and local requirements specified in paragraph SAFETY AND HEALTH PROGRAM AND PLANS for those asbestos abatement activities that they will be involved in."

#### 1.5.2 Specific Requirements

The Contractor shall designate in writing, personnel meeting the following qualifications:

- a. Designated Competent Person: The name, address, telephone number, and resume of the Contractor's Designated Competent Person shall be provided. Evidence that the full-time Designated Competent Person is qualified in accordance with 29 CFR 1926, Sections .32 and .1101, has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, and is experienced in the administration and supervision of asbestos abatement projects, including exposure and assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement

and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, etc. The duties of the Competent Person shall include the following: controlling entry to and exit from the regulated area; supervising any employee exposure monitoring required by 29 CFR 1926, Section .1101; ensuring that all employees working within a regulated area wear the appropriate personal protective equipment (PPE), are trained in the use of appropriate methods of exposure control, and use the hygiene facilities and decontamination procedures specified; and ensuring that engineering controls in use are in proper operating conditions and are functioning properly. The Designated Competent Person shall be responsible for compliance with applicable federal, state and local requirements, the Contractor's Accident Prevention Plan and Asbestos Hazard Abatement Plan. The Designated Competent Person shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Contractor shall submit evidence that this person has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA competent person requirements. The Designated Competent Person shall be onsite at all times during the conduct of this project.

- b. Project and Other Supervisors: The Contractor shall provide the name, address, telephone number, and resume of the Project Supervisor and other supervisors who have responsibility to implement the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses, the authority to direct work performed under this contract and verify compliance, and have EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C. The Project Supervisor and other supervisors shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Contractor shall submit evidence that the Project Supervisor has a minimum of 2 years of on-the-job asbestos abatement experience relevant to project supervisor responsibilities and the other supervisors have a minimum of 1 year on-the-job asbestos abatement experience commensurate with the responsibilities they will have on this project.
- c. Designated Industrial Hygienist: The Contractor shall provide the name, address, telephone number, resume and other information specified below for the Industrial Hygienist (IH) selected to prepare the Contractor's Asbestos Hazard Abatement Plan, prepare and perform training, direct air monitoring and assist the Contractor's Competent Person in implementing and ensuring that safety and health requirements are complied with during the performance of all required work. The Designated IH shall be a person who is board certified in the practice of industrial hygiene as determined and documented by the American Board of Industrial Hygiene (ABIH), has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training accreditation required by 40 CFR 763, Subpart E, Appendix C, and has a minimum of 2 years of

comprehensive experience in planning and overseeing asbestos abatement activities. The Designated IH shall provide, and the Contractor shall submit, the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training with the employee "Certificate of Worker Acknowledgment" required by this paragraph. The Designated IH shall be completely independent from the Contractor according to federal, state, or local regulations; that is, shall not be a Contractor's employee or be an employee or principal of a firm in a business relationship with the Contractor negating such independent status. A copy of the Designated IH's current valid ABIH certification shall be included. The Designated IH shall visit the site at least twice per week for the duration of asbestos activities and shall be available for emergencies. In addition, the Designated IH shall prepare, and the Contractor shall submit, the name, address, telephone numbers and resumes of additional IH's and industrial hygiene technicians (IHT) who will be assisting the Designated IH in performing onsite tasks. IHs and IHTs supporting the Designated IH shall have a minimum of 2 years of practical onsite asbestos abatement experience. The formal reporting relationship between the Designated IH and the support IHs and IHTs, the Designated Competent Person, and the Contractor shall be indicated.

- d. Asbestos Abatement Workers: Asbestos abatement workers shall meet the requirements contained in 29 CFR 1926, Section .1101, 40 CFR 61, Subpart M, and other applicable federal, state and local requirements. Worker training documentation shall be provided as required on the "Certificate of Workers Acknowledgment" in this paragraph.
- e. Worker Training and Certification of Worker Acknowledgment: Training documentation will be required for each employee who will perform OSHA Class I asbestos abatement operations. Such documentation shall be submitted on a Contractor generated form titled "Certificate of Workers Acknowledgment", to be completed for each employee in the same format and containing the same information as the example certificate at the end of this section. Training course completion certificates (initial and most recent update refresher) required by the information checked on the form shall be attached.
- f. Physician: The Contractor shall provide the name, medical qualifications, address, telephone number and resume of the physician who will or has performed the medical examinations and evaluations of the persons who will conduct the asbestos abatement work tasks. The physician shall be currently licensed by the state where the workers will be or have been examined, have expertise in pneumoconiosis and shall be responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1926, Section .1101 and paragraph MEDICAL REQUIREMENTS. The physician shall be familiar with the site's hazards and the scope of this project.
- g. First Aid and CPR Trained Persons: The names of at least 2 persons who are currently trained in first aid and CPR by the American Red Cross or other approved agency shall be designated and shall be onsite at all times during site operations. They shall be trained in universal precautions and the use of PPE as described in the

Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030 and shall be included in the Contractor's Bloodborne Pathogen Program. These persons may perform other duties but shall be immediately available to render first aid when needed. A copy of each designated person's current valid First Aid and CPR certificate shall be provided.

- h. Independent Testing Laboratory: The Contractor shall provide the name, address and telephone number of the independent testing laboratory selected to perform the sample analyses and report the results. The testing laboratory shall be completely independent from the Contractor as recognized by federal, state or local regulations. Written verification of the following criteria, signed by the testing laboratory principal and the Contractor, shall be submitted:

(1) Phase contrast microscopy (PCM): The laboratory is fully equipped and proficient in conducting PCM of airborne samples using the methods specified by 29 CFR 1926, Section .1101, OSHA method ID-160, the most current version of NIOSH Pub No. 84-100 Method 7400.

The laboratory is currently judged proficient (classified as acceptable) in counting airborne asbestos samples by PCM by successful participation in each of the last 4 rounds in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program; the names of the selected microscopists who will analyze airborne samples by PCM with verified documentation of their proficiency to conduct PCM analyses by being judged proficient in counting samples as current participating analysts in the AIHA PAT Program, and having successfully completed the Asbestos Sampling and Analysis course (NIOSH 582 or equivalent) with a copy of course completion certificate provided; when the PCM analysis is to be conducted onsite, documentation shall be provided certifying that the onsite analyst meets the same requirements.

(2) Polarized light microscopy (PLM): The laboratory is fully equipped and proficient in conducting PLM analyses of suspect ACM bulk samples in accordance with 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for bulk asbestos analysis and will use analysts (names shall be provided) with demonstrated proficiency to conduct PLM to include its application to the identification and quantification of asbestos content.

(4) PCM/TEM: The laboratory is fully equipped and each analyst (name shall be provided) possesses demonstrated proficiency in conducting PCM and TEM analysis of airborne samples using NIOSH Pub No. 84-100 Method 7400 PCM and NIOSH Pub No. 84-100 Method 7402 (TEM confirmation of asbestos content of PCM results) from the same filter.

- i. Disposal Facility, Transporter: The Contractor shall provide written evidence that the landfill to be used is approved for asbestos disposal by the USEPA and state and local regulatory agencies. Copies of signed agreements between the Contractor (including subcontractors and transporters) and the asbestos waste disposal facility to accept and dispose of all asbestos containing

waste generated during the performance of this contract shall be provided. Qualifications shall be provided for each subcontractor or transporter to be used, indicating previous experience in transport and disposal of asbestos waste to include all required state and local waste hauler requirements for asbestos. The Contractor and transporters shall meet the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and other applicable state or local requirements. The disposal facility shall meet the requirements of 40 CFR 61, Sections .154 or .155, as required in 40 CFR 61, Section .150(b), and other applicable state or local requirements.

#### 1.5.3 Federal, State or Local Citations on Previous Projects

The Contractor and all subcontractors shall submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company shall be provided.

#### 1.6 REGULATORY REQUIREMENTS

In addition to detailed requirements of this specification, work performed under this contract shall comply with EM 385-1-1, applicable federal, state, and local laws, ordinances, criteria, rules and regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. This includes, but is not limited to, OSHA standards, 29 CFR 1926, especially Section .1101, 40 CFR 61, Subpart M and 40 CFR 763. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements shall apply.

#### 1.7 SAFETY AND HEALTH PROGRAM AND PLANS

The Contractor shall develop and submit a written comprehensive site-specific Accident Prevention Plan at least 30 days prior to the preconstruction conference. The Accident Prevention Plan shall address requirements of EM 385-1-1, Appendix A, covering onsite work to be performed by the Contractor and subcontractors. The Accident Prevention Plan shall incorporate an Asbestos Hazard Abatement Plan, and Activity Hazard Analyses as separate appendices into 1 site specific Accident Prevention Plan document. Any portions of the Contractor's overall Safety and Health Program that are referenced in the Accident Prevention Plan, e.g., respirator program, hazard communication program, confined space entry program, etc., shall be included as appendices to the Accident Prevention Plan. The plan shall take into consideration all the individual asbestos abatement work tasks identified in Table 1. The plan shall be prepared, signed (and sealed, including certification number if required), and dated by the Contractor's Designated IH, Competent Person, and Project Supervisor.

##### 1.7.1 Asbestos Hazard Abatement Plan Appendix

The Asbestos Hazard Abatement Plan appendix to the Accident Prevention Plan shall include, but not be limited to, the following:

- a. The personal protective equipment to be used;
- b. The location and description of regulated areas including clean and dirty areas, and decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit);
- c. Initial exposure assessment in accordance with 29 CFR 1926, Section .1101;
- d. Level of supervision;
- e. Method of notification of other employers at the worksite;
- f. Abatement method to include containment and control procedures;
- g. Interface of trades involved in the construction;
- h. Sequencing of asbestos related work;
- i. Storage and disposal procedures and plan;
- j. Type of wetting agent to be used;
- k. Location of local exhaust equipment;
- l. Air monitoring methods (personal, environmental and clearance);
- m. Bulk sampling and analytical methods (if required);
- n. A detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber concentrations;
- o. Fire and medical emergency response procedures;
- p. The security procedures to be used for all regulated areas.

#### 1.7.2 Activity Hazard Analyses Appendix

Activity Hazard Analyses, for each major phase of work, shall be submitted and updated during the project. The Activity Hazard Analyses format shall be in accordance with EM 385-1-1 (Figure 1-1). The analysis shall define the activities to be performed for a major phase of work, identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not proceed on that phase until the Activity Hazard Analyses has been accepted and a preparatory meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activities, including the onsite Government representatives. The Activity Hazard Analyses shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations.

#### 1.8 PRECONSTRUCTION CONFERENCE AND ONSITE SAFETY

The Contractor and the Contractor's Designated Competent Person, Project Supervisor, and Designated IH shall meet with the Contracting Officer prior to beginning work at a safety preconstruction conference to discuss the

details of the Contractor's submitted Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses appendices. Deficiencies in the Accident Prevention Plan will be discussed and the Accident Prevention Plan shall be revised to correct the deficiencies and resubmitted for acceptance. Any changes required in the specification as a result of the Accident Prevention Plan shall be identified specifically in the plan to allow for free discussion and acceptance by the Contracting Officer, prior to the start of work. Onsite work shall not begin until the Accident Prevention Plan has been accepted. A copy of the written Accident Prevention Plan shall be maintained onsite. Changes and modifications to the accepted Accident Prevention Plan shall be made with the knowledge and concurrence of the Designated IH, the Project Supervisor, Designated Competent Person, and the Contracting Officer. Should any unforeseen hazard become evident during the performance of the work, the Designated IH shall bring such hazard to the attention of the Project Supervisor, Designated Competent Person, and the Contracting Officer, both verbally and in writing, for resolution as soon as possible. In the interim, all necessary action shall be taken by the Contractor to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Once accepted by the Contracting Officer, the Accident Prevention Plan, including the Asbestos Hazard Abatement Plan and Activity Hazard Analyses will be enforced as if an addition to the contract. Disregarding the provisions of this contract or the accepted Accident Prevention Plan will be cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified. .

#### 1.9 SECURITY

Locked security area shall be provided for each regulated area. A log book shall be kept documenting entry into and out of the regulated area. Entry into regulated areas shall only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas shall be trained, be medically evaluated, and wear the required personal protective equipment for the specific regulated area to be entered.

#### 1.10 MEDICAL REQUIREMENTS

Medical requirements shall conform to 29 CFR 1926, Section .1101.

##### 1.10.1 Medical Examinations

Before being exposed to airborne asbestos fibers, workers shall be provided with a medical examination as required by 29 CFR 1926, Section .1101 and other pertinent state or local requirements. This requirement shall have been satisfied within the last 12 months. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. X-ray films of asbestos workers shall be identified to the consulting radiologist and medical record jackets shall be marked with the word "asbestos."

##### 1.10.1.1 Information Provided to the Physician

The Contractor shall provide the following information in writing to the examining physician:

- a. A copy of 29 CFR 1926, Section .1101 and Appendices D, E, G, and I;

- b. A description of the affected employee's duties as they relate to the employee's exposure;
- c. The employee's representative exposure level or anticipated exposure level;
- d. A description of any personal protective and respiratory equipment used or to be used;
- e. Information from previous medical examinations of the affected employee that is not otherwise available to the examining physician.

#### 1.10.1.2 Written Medical Opinion

For each worker, a written medical opinion prepared and signed by a licensed physician indicating the following:

- a. Summary of the results of the examination.
- b. The potential for an existing physiological condition that would place the employee at an increased risk of health impairment from exposure to asbestos.
- c. The ability of the individual to wear personal protective equipment, including respirators, while performing strenuous work tasks under cold and/or heat stress conditions.
- d. A statement that the employee has been informed of the results of the examination, provided with a copy of the results, informed of the increased risk of lung cancer attributable to the combined effect of smoking and asbestos exposure, and informed of any medical condition that may result from asbestos exposure.

#### 1.10.2 Medical and Exposure Records

Complete and accurate records shall be maintained of each employee's medical examinations, medical records, and exposure data, as required by 29 CFR 1910, Section .1910.20 and 29 CFR 1926, Section .1101 for an indefinite period of years after termination of employment. Records of the required medical examinations and exposure data shall be made available, for inspection and copying, to the Assistant Secretary of Labor for Occupational Safety and Health (OSHA) or authorized representatives of the employee and an employee's physician upon request of the employee or former employee. A copy of the required medical certification for each employee shall be maintained on file at the worksite for review, as requested by the Contracting Officer or the representatives.

#### 1.11 TRAINING PROGRAM

##### 1.11.1 General Training Requirements

The Contractor shall establish a training program as specified by EPA Model Accreditation Plan (MAP), training requirements at 40 CFR 763, Subpart E, Appendix C, the Commonwealth of Virginia, OSHA requirements at 29 CFR 1926, Section .1101(k)(9), and this specification. Contractor employees shall complete the required training for the type of work they are to perform and such training shall be documented and provided to the Contracting Officer as specified in paragraph QUALIFICATIONS.

### 1.11.2 Project Specific Training

Prior to commencement of work, each worker shall be instructed by the Contractor's Designated IH and Competent Person in the following project specific training:

- a. The hazards and health effects of the specific types of ACM to be abated;
- b. The content and requirements of the Contractor's Accident Prevention Plan to include the Asbestos Hazard Abatement Plan and Activity Hazard Analyses and site-specific safety and health precautions;
- c. Hazard Communication Program;
- d. Hands-on training for each asbestos abatement technique to be employed;
- e. Heat and/or cold stress monitoring specific to this project;
- f. Air monitoring program and procedures;
- g. Medical surveillance to include medical and exposure record-keeping procedures;
- h. The association of cigarette smoke and asbestos-related disease;
- i. Security procedures;
- j. Specific work practice controls and engineering controls required for each Class of work in accordance with 29 CFR 1926, Section .1101.

### 1.12 RESPIRATORY PROTECTION PROGRAM

The Contractor's Designated IH shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926, Section .1101, 29 CFR 1910, Section .134, ANSI Z88.2, CGA G-7, CGA G-7.1. The Contractor's Designated IH shall establish minimum respiratory protection requirements based on measured or anticipated levels of airborne asbestos fiber concentrations encountered during the performance of the asbestos abatement work. The Contractor's respiratory protection program shall include, but not be limited to, the following elements:

- a. The company policy, used for the assignment of individual responsibility, accountability, and implementation of the respiratory protection program.
- b. The standard operating procedures covering the selection and use of respirators. Respiratory selection shall be determined by the hazard to which the worker is exposed.
- c. Medical evaluation of each user to verify that the worker may be assigned to an activity where respiratory protection is required.
- d. Training in the proper use and limitations of respirators.
- e. Respirator fit-testing, i.e., quantitative, qualitative and individual functional fit checks.

- f. Regular cleaning and disinfection of respirators.
- g. Routine inspection of respirators during cleaning and after each use when designated for emergency use.
- h. Storage of respirators in convenient, clean, and sanitary locations.
- i. Surveillance of regulated area conditions and degree of employee exposure (e.g., through air monitoring).
- j. Regular evaluation of the continued effectiveness of the respiratory protection program.
- k. Recognition and procedures for the resolution of special problems as they affect respirator use (e.g., no facial hair that comes between the respirator face piece and face or interferes with valve function; prescription eye wear usage; contact lenses usage; etc.).
- l. Proper training in putting on and removing respirators.

#### 1.12.1 Respiratory Fit Testing

A qualitative or quantitative fit test conforming to 29 CFR 1926, Section 1101, Appendix C shall be conducted by the Contractor's Designated IH for each Contractor worker required to wear a respirator, and for the Contracting Officer and authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test shall be performed for each worker wearing a negative-pressure respirator prior to initially wearing a respirator on this project and every 6 months thereafter. The qualitative fit tests may be used only for testing the fit of half-mask respirators where they are permitted to be worn, or of full-facepiece air purifying respirators where they are worn at levels at which half-facepiece air purifying respirators are permitted. If physical changes develop that will affect the fit, a new fit test for the worker shall be performed. Functional fit checks shall be performed by employees each time a respirator is put on and in accordance with the manufacturer's recommendation.

#### 1.12.2 Respirator Selection and Use Requirements

The Contractor shall provide respirators, and ensure that they are used as required by 29 CFR 1926, Section .1101 and in accordance with the manufacturer's recommendations. Respirators shall be jointly approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA/NIOSH), or by NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. Personnel who handle ACM, enter regulated areas that require the wearing of a respirator, or who are otherwise carrying out abatement activities that require the wearing of a respirator, shall be provided with approved respirators that are fully protective of the worker at the measured or anticipated airborne asbestos concentration level to be encountered. For air-purifying respirators, the particulate filter portion of the cartridges or canister approved for use in airborne asbestos environments shall be high-efficiency particulate air (HEPA). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type shall be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered. Recommendations made by the Contractor's

Designated IH to downgrade respirator type shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person in consultation with the Designated IH, shall have the authority to take immediate action to upgrade or downgrade respiratory type when there is an immediate danger to the health and safety of the wearer. Respirators shall be used in the following circumstances:

a. During all Class I asbestos jobs.

g. During all work where employees are exposed above the PEL-TWA or PEL-Excursion Limit.

h. In emergencies

#### 1.12.3 Class I Work

The Contractor shall provide: (1) a tight-fitting, powered air purifying respirator equipped with high efficiency filters, or (2) a full-facepiece supplied air respirator operated in the pressure demand mode, equipped with HEPA egress cartridges, or (3) an auxiliary positive pressure self-contained breathing apparatus, for all employees within the regulated area where Class I work is being performed; provided that a negative exposure assessment has not been produced, and that the exposure level will not exceed 1 f/cc as an 8-hour time weighted average. A full-facepiece supplied air respirator, operated in the pressure demand mode, equipped with an auxiliary positive pressure self-contained breathing apparatus shall be provided under such conditions, if the exposure assessment indicates exposure levels above 1 f/cc as an 8-hour time weighted average.

#### 1.12.4 Sanitation

Employees who wear respirators shall be permitted to leave work areas to wash their faces and respirator facepieces whenever necessary to prevent skin irritation associated with respirator use.

#### 1.13 HAZARD COMMUNICATION PROGRAM

A hazard communication program shall be established and implemented in accordance with 29 CFR 1926, Section .59. Material safety data sheets (MSDSs) shall be provided for all hazardous materials brought onto the worksite. One copy shall be provided to the Contracting Officer and 1 copy shall be included in the Contractor's Hazard Communication Program.

#### 1.14 LICENSES, PERMITS AND NOTIFICATIONS

##### 1.14.1 General Legal Requirements

Necessary licenses, permits and notifications shall be obtained in conjunction with the project's asbestos abatement, transportation and

disposal actions and timely notification furnished of such actions as required by federal, state, regional, and local authorities. The Contractor shall notify the Regional Office of the USEPA state's environmental protection agency responsible for asbestos air emissions local air pollution control district/agency state OSHA program and the Contracting Officer in writing, at least 20 days prior to the commencement of work, in accordance with 40 CFR 61, Subpart M, and state and local requirements to include the mandatory "Notification of Demolition and Renovation Record" form and other required notification documents. Notification shall be by Certified Mail, Return Receipt Requested. The Contractor shall furnish copies of the receipts to the Contracting Officer, in writing, prior to the commencement of work. A copy of the rental company's written acknowledgment and agreement shall be provided as required by paragraph RENTAL EQUIPMENT. For licenses, permits, and notifications that the Contractor is responsible for obtaining, the Contractor shall pay any associated fees or other costs incurred.

#### 1.14.2 Litigation and Notification

The Contractor shall notify the Contracting Officer if any of the following occur:

- a. The Contractor or any of the subcontractors are served with notice of violation of any law, regulation, permit or license which relates to this contract;
- b. Proceedings are commenced which could lead to revocation of related permits or licenses; permits, licenses or other Government authorizations relating to this contract are revoked;
- c. Litigation is commenced which would affect this contract;
- d. The Contractor or any of the subcontractors become aware that their equipment or facilities are not in compliance or may fail to comply in the future with applicable laws or regulations.

#### 1.15 PERSONAL PROTECTIVE EQUIPMENT

Unlimited sets of personal protective equipment shall be made available to the Contracting Officer and authorized visitors for entry to the regulated area. Contracting Officer and authorized visitors shall be provided with training equivalent to that provided to Contractor employees in the selection, fitting, and use of the required personal protective equipment and the site safety and health requirements. Contractor workers shall be provided with personal protective clothing and equipment and the Contractor shall ensure that it is worn properly. The Contractor's Designated IH and Designated Competent Person shall select and approve all the required personal protective clothing and equipment to be used.

##### 1.15.1 Respirators

Respirators shall be in accordance with paragraph RESPIRATORY PROTECTION PROGRAM.

##### 1.15.2 Whole Body Protection

Personnel exposed to airborne concentrations of asbestos that exceed the PELs, or for all OSHA Classes of work for which a required negative exposure assessment is not produced, shall be provided with whole body

protection and such protection shall be worn properly. The Contractor's Designated IH and Competent Person shall select and approve the whole body protection to be used. The Competent Person shall examine work suits worn by employees at least once per work shift for rips or tears that may occur during performance of work. When rips or tears are detected while an employee is working, rips and tears shall be immediately mended, or the work suit shall be immediately replaced. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the regulated area. Reusable whole body protection worn shall be either disposed of as asbestos contaminated waste upon exiting from the regulated area or be properly laundered in accordance with 29 CFR 1926, Section .1101.

Whole body protection used for asbestos abatement shall not be removed from the worksite by a worker to be cleaned. Recommendations made by the Contractor's Designated IH to downgrade whole body protection shall be submitted in writing to the Contracting Officer. The Contractor's Designated Competent Person, in consultation with the Designated IH, has the authority to take immediate action to upgrade or downgrade whole body protection when there is an immediate danger to the health and safety of the wearer.

#### 1.15.2.1 Coveralls

Disposable-breathable coveralls with a zipper front shall be provided. Sleeves shall be secured at the wrists, and foot coverings secured at the ankles.

#### 1.15.2.2 Gloves

Gloves shall be provided to protect the hands. Where there is the potential for hand injuries (i.e., scrapes, punctures, cuts, etc.) a suitable glove shall be provided and used.

#### 1.15.2.3 Foot Coverings

Cloth socks shall be provided and worn next to the skin. Footwear, as required by OSHA and EM 385-1-1, that is appropriate for safety and health hazards in the area shall be worn. Rubber boots shall be used in moist or wet areas. Reusable footwear removed from the regulated area shall be thoroughly decontaminated or disposed of as ACM waste. Disposable protective foot covering shall be disposed of as ACM waste. If rubber boots are not used, disposable foot covering shall be provided.

#### 1.15.2.4 Head Covering

Hood type disposable head covering shall be provided. In addition, protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the regulated area after being thoroughly decontaminated.

#### 1.15.2.5 Protective Eye Wear

Eye protection provided shall be in accordance with ANSI Z87.1.

### 1.16 HYGIENE FACILITIES AND PRACTICES

The Contractor shall establish a decontamination area for the decontamination of employees, material and equipment. The Contractor shall ensure that employees enter and exit the regulated area through the decontamination area.

#### 1.16.1 Shower Facilities

Shower facilities, when provided, shall comply with 29 CFR 1910, Section .141(d)(3).

#### 1.16.2 3-Stage Decontamination Area

A temporary negative pressure decontamination unit that is adjacent and attached in a leak-tight manner to the regulated area shall be provided.. The decontamination unit shall have an equipment room and a clean room separated by a shower that complies with 29 CFR 1910, Section .141 (unless the Contractor can demonstrate that such facilities are not feasible). Equipment and surfaces of containers filled with ACM shall be cleaned prior to removing them from the equipment room or area. Surfaces of the equipment room shall be wet wiped 2 times after each shift. Materials used for wet wiping shall be disposed of as asbestos contaminated waste. Two separate lockers shall be provided for each asbestos worker, one in the equipment room and one in the clean room. Hot water service may be secured from the building hot water system provided backflow protection is installed by the Contractor at the point of connection. The Contractor shall provide a minimum of one shower per regulated area. Instantaneous type in-line water heater may be incorporated at each shower head in lieu of hot water heater, upon approval by the Contracting Officer. Flow and temperature controls shall be located within the shower and shall be adjustable by the user. The wastewater pump shall be sized for 1.25 times the showerhead flow-rate at a pressure head sufficient to satisfy the filter head loss and discharge line losses. The pump shall supply a minimum 25 gpm flow with 35 ft. of pressure head. Used shower water shall be collected and filtered to remove asbestos contamination. Filters and residue shall be disposed of as asbestos contaminated material Filtered water shall be discharged to the sanitary system. Wastewater filters shall be installed in series with the first stage pore size of 20 microns and the second stage pore size of 5 microns. The floor of the decontamination unit's clean room shall be kept dry and clean at all times. Water from the shower shall not be allowed to wet the floor in the clean room. Surfaces of the clean room and shower shall be wet-wiped 2 times after each shift change with a disinfectant solution. Proper housekeeping and hygiene requirements shall be maintained. Soap and towels shall be provided for showering, washing and drying. Any cloth towels provided shall be disposed of as ACM waste or shall be laundered in accordance with 29 CFR 1926, Section .1101.

#### 1.16.3 Load-Out Unit

A temporary load-out unit that is adjacent and connected to the regulated area shall be provided. The load-out unit shall be attached in a leak-tight manner to each regulated area. Surfaces of the load-out unit shall be adequately wet-wiped 2 times after each shift change. Materials used for wet wiping shall be disposed of as asbestos contaminated waste.

#### 1.16.4 Decontamination Area Entry Procedures

The Contractor shall ensure that employees entering the decontamination area through the clean room or clean area:

- a. Remove street clothing in the clean room or clean area and deposit it in lockers.
- b. Put on protective clothing and respiratory protection before

leaving the clean room or clean area.

- c. Pass through the equipment room to enter the regulated area.

#### 1.16.5 Decontamination Area Exit Procedures

The Contractor shall ensure that the following procedures are followed:

- a. Before leaving the regulated area, respirators shall be worn while employees remove all gross contamination and debris from their work clothing using a HEPA vacuum.
- b. Employees shall remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers (see Detail Sheets 9 and 14) for disposal and/or laundering.
- c. Employees shall not remove their respirators in the equipment room.
- d. Employees shall shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, the Contractor shall ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.
- e. After showering, employees shall enter the clean room before changing into street clothes.

#### 1.16.6 Smoking

Smoking, if allowed by the Contractor, shall only be permitted in designated areas approved by the Contracting Officer.

#### 1.17 REGULATED AREAS

All Class I, asbestos work shall be conducted within regulated areas. The regulated area shall be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they shall demarcate the regulated area. Access to regulated areas shall be limited to authorized persons. The Contractor shall control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

#### 1.18 WARNING SIGNS AND TAPE

Warning signs and tape printed in English shall be provided at the regulated boundaries and entrances to regulated areas. The Contractor shall ensure that all personnel working in areas contiguous to regulated areas comprehend the warning signs. Signs shall be located to allow personnel to read the signs and take the necessary protective steps required before entering the area. Warning signs shall be in vertical

format conforming to 29 CFR 1910 and 29 CFR 1926, Section .1101, a minimum of 20 by 14 inches, and displaying the following legend in the lower panel:

DANGER  
ASBESTOS  
CANCER AND LUNG DISEASE HAZARD  
AUTHORIZED PERSONNEL ONLY  
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

Spacing between lines shall be at least equal to the height of the upper of any two lines.

#### 1.19 WARNING LABELS

Warning labels shall be affixed to all asbestos disposal containers used to contain asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements are acceptable. Warning labels shall conform to 29 CFR 1926, Section .1101 and shall be of sufficient size to be clearly legible displaying the following legend:

DANGER  
CONTAINS ASBESTOS FIBERS  
AVOID CREATING DUST  
CANCER AND LUNG DISEASE HAZARD

#### 1.20 LOCAL EXHAUST VENTILATION

Local exhaust ventilation units shall conform to ANSI Z9.2 and 29 CFR 1926, Section .1101. Filters on local exhaust system equipment shall conform to ANSI Z9.2 and UL 586. Filter shall be UL labeled.

#### 1.21 TOOLS

Vacuums shall be leak proof to the filter, equipped with HEPA filters, of sufficient capacity and necessary capture velocity at the nozzle or nozzle attachment to efficiently collect, transport and retain the ACM waste material. Power tools shall not be used to remove ACM unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation capture and collection system, or has otherwise been approved for use by the Contracting Officer. Residual asbestos shall be removed from reusable tools prior to storage and reuse. Reusable tools shall be thoroughly decontaminated prior to being removed from regulated areas.

#### 1.22 RENTAL EQUIPMENT

If rental equipment is to be used, written notification shall be provided to the rental agency, concerning the intended use of the equipment, the possibility of asbestos contamination of the equipment and the steps that will be taken to decontaminate such equipment. A written acceptance of the terms of the Contractor's notification shall be obtained from the rental agency.

#### 1.23 AIR MONITORING EQUIPMENT

The Contractor's Designated IH shall approve air monitoring equipment to be used to collect samples. The equipment shall include, but shall not be limited to:

- a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute when equipped with a sampling train of tubing and filter cassette.
- b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute when equipped with a sampling train of tubing and filter cassette, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps shall also be equipped with an automatic flow control unit which shall maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.
- c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands, to be used with low flow pumps in accordance with 29 CFR 1926, Section .1101 for personal air sampling.
- d. Single use standard 25 mm diameter cassette, open face, 0.45 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive cowl, and shrink bands, to be used with high flow pumps when conducting environmental area sampling using NIOSH Pub No. 84-100 Methods 7400 and 7402, (and the transmission electric microscopy method specified at 40 CFR 763 if required).
- e. Appropriate plastic tubing to connect the air sampling pump to the selected filter cassette.
- f. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

#### 1.24 EXPENDABLE SUPPLIES

##### 1.24.1 Duct Tape

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container shall be provided.

##### 1.24.2 Disposal Containers

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926 Section .1101.

##### 1.24.3 Disposal Bags

Leak-tight bags, 6 mil thick, shall be provided for placement of asbestos generated waste.

##### 1.24.4 Sheet Plastic

Sheet plastic shall be polyethylene of 6 mil minimum thickness and shall be provided in the largest sheet size necessary to minimize seams. Film shall conform to ASTM D 4397, except as specified below:

#### 1.24.4.1 Flame Resistant

Where a potential for fire exists, flame-resistant sheets shall be provided. Film shall be black and shall conform to the requirements of NFPA 701.

#### 1.24.4.2 Reinforced

Reinforced sheets shall be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock shall consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film shall meet flame resistant standards of NFPA 701.

#### 1.24.5 Amended Water

Amended water shall meet the requirements of ASTM D 1331.

#### 1.24.6 Leak-tight Wrapping

Two layers of 6 mil minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as reactor vessels, large tanks, boilers, insulated pipe segments and other materials too large to be placed in disposal bags. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.

#### 1.24.7 Wetting Agents

Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS.

#### 1.24.8 Strippable Coating

Strippable coating in aerosol cans shall be used to adhere to surfaces and to be removed cleanly by stripping, at the completion of work. This work shall only be done in well ventilated areas.

### 1.25 MISCELLANEOUS ITEMS

A sufficient quantity of other items, such as, but not limited to: scrapers, brushes, brooms, staple guns, tarpaulins, shovels, rubber squeegees, dust pans, other tools, scaffolding, staging, enclosed chutes, wooden ladders, lumber necessary for the construction of containments, UL approved temporary electrical equipment, material and cords, ground fault circuit interrupters, water hoses of sufficient length, fire extinguishers, first aid kits, portable toilets, logbooks, log forms, markers with indelible ink, spray paint in bright color to mark areas, project boundary fencing, etc., shall be provided.

## PART 2 PRODUCTS

### 2.1 ENCAPSULANTS

Encapsulants shall conform to USEPA requirements, shall contain no toxic or hazardous substances and no solvent and shall meet the following requirements:

## ALL ENCAPSULANTS

Requirement	Test Standard
Flame Spread - 25, Smoke Emission - 50	ASTM E 84
Combustion Toxicity Zero Mortality	Univ. of Pittsburgh Protocol
Life Expectancy, 20 yrs Accelerated Aging Test	ASTM C 732
Permeability, Minimum 0.4 perms	ASTM E 96

## Additional Requirements for Lockdown Encapsulant

Requirement	Test Standard
Fire Resistance, Negligible affect on fire resistance rating over 3 hour test (Tested with fireproofing over encapsulant applied directly to steel member)	ASTM E 119
Bond Strength, 100 pounds of force/foot (Tests compatibility with cementitious and fibrous fireproofing)	ASTM E 736

## PART 3 EXECUTION

## 3.1 GENERAL REQUIREMENTS

Asbestos abatement work tasks shall be performed as shown on the hazardous materials demolition drawings, as summarized in paragraph DESCRIPTION OF WORK and including Table 1 and the Contractor's Accident Prevention Plan, Asbestos Hazard Abatement Plan, and the Activity Hazard Analyses. The Contractor shall use the engineering controls and work practices required in 29 CFR 1926, Section .1101(g) in all operations regardless of the levels of exposure. Personnel shall wear and utilize protective clothing and equipment as specified. The Contractor shall not permit eating, smoking, drinking, chewing or applying cosmetics in the regulated area. All hot work (burning, cutting, welding, etc.) shall be conducted under controlled conditions in conformance with 29 CFR 1926, Section .352, Fire Prevention. Personnel of other trades, not engaged in asbestos abatement activities, shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions of the Contractor's Accident Prevention Plan are complied with. Power to the regulated area shall be locked-out and tagged in accordance with 29 CFR 1910, and temporary electrical service with ground fault circuit interrupters shall be provided as needed. Temporary electrical service shall be disconnected when necessary for wet removal. The Contractor shall stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement

concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. The Contractor shall correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work shall resume only upon notification by the Contracting Officer. Corrective actions shall be documented.

### 3.2 PROTECTION OF ADJACENT WORK OR AREAS TO REMAIN

Asbestos abatement shall be performed without damage to or contamination of adjacent work or area. Where such work or area is damaged or contaminated, as verified by the Contracting Officer using visual inspection or sample analysis, it shall be restored to its original condition or decontaminated by the Contractor at no expense to the Government, as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, work shall stop in all effected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and air sampling analysis results are obtained and have been evaluated by the Contractor's Designated IH and the Contracting Officer, work shall proceed.

### 3.3 OBJECTS

#### 3.3.1 Removal of Mobile Objects

Mobile objects, furniture, and equipment will be removed from buildings by the Government before asbestos abatement work begins.

### 3.4 BUILDING VENTILATION SYSTEM AND CRITICAL BARRIERS

Building ventilating systems supplying air into or returning air out of a regulated area shall be shut down and isolated by lockable switch or other positive means in accordance with 29 CFR 1910, Section.147. Air-tight critical barriers shall be installed on building ventilating openings located inside the regulated area that supply or return air from the building ventilation system or serve to exhaust air from the building. The critical barriers shall consist of air-tight rigid covers for building ventilation supply and exhaust grills where the ventilation system is required to remain in service during abatement. Edges to wall, ceiling and floor surfaces shall be sealed with industrial grade duct tape.

### 3.5 PRECLEANING

Surfaces shall be cleaned by HEPA vacuum and adequately wet wiped prior to establishment of containment.

### 3.6 METHODS OF COMPLIANCE

#### 3.6.1 Mandated Practices

The Contractor shall employ proper handling procedures in accordance with 29 CFR 1926 and 40 CFR 61, Subpart M, and the specified requirements. The specific abatement techniques and items identified shall be detailed in the Contractor's Asbestos Hazard Abatement Plan including, but not limited to, details of construction materials, equipment, and handling procedures. The Contractor shall use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

- a. Vacuum cleaners equipped with HEPA filters to collect debris and

dust containing ACM.

- b. Wet methods or wetting agents to control employee exposures during asbestos handling, mixing, removal, cutting, application, and cleanup; except where it can be demonstrated that the use of wet methods is unfeasible due to, for example, the creation of electrical hazards, equipment malfunction, and in roofing.
- c. Prompt clean-up and disposal in leak-tight containers of wastes and debris contaminated with asbestos.
- d. Inspection and repair of polyethylene in work and high traffic areas.
- e. Cleaning of equipment and surfaces of containers filled with ACM prior to removing them from the equipment room or area.

### 3.6.2 Control Methods

The Contractor shall use the following control methods to comply with the PELs:

- a. Local exhaust ventilation equipped with HEPA filter dust collection systems;
- b. Enclosure or isolation of processes producing asbestos dust;
- c. Ventilation of the regulated area to move contaminated air away from the breathing zone of employees and toward a filtration or collection device equipped with a HEPA filter;
- d. Use of other work practices and engineering controls;
- e. Where the feasible engineering and work practice controls described above are not sufficient to reduce employee exposure to or below the PELs, the Contractor shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with paragraph, RESPIRATORY PROTECTION PROGRAM.

### 3.6.3 Unacceptable Practices

The following work practices and engineering controls shall not be used for work related to asbestos or for work which disturbs ACM, regardless of measured levels of asbestos exposure or the results of initial exposure assessments:

- a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.
- b. Compressed air used to remove asbestos, or materials containing asbestos, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.
- c. Dry sweeping, shoveling, or other dry clean-up of dust and debris containing ACM.
- d. Employee rotation as a means of reducing employee exposure to

asbestos.

#### 3.6.4 Class I Work Procedures

In addition to requirements of paragraphs Mandated Practices and Control Methods, the following engineering controls and work practices shall be used:

- a. A Competent Person shall supervise the installation and operation of the control system.
- b. For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, the Contractor shall place critical barriers over all openings to the regulated area.
- c. HVAC systems shall be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.
- d. Impermeable dropcloths ( 6 mil or greater thickness) shall be placed on surfaces beneath all removal activity.
- e. Objects within the regulated area shall be handled as specified in paragraph OBJECTS.
- f. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area shall be ventilated to move contaminated air away from the employee's breathing zone toward a HEPA unit or collection device.

#### 3.6.5 Specific Control Methods for Class I Work

In addition to requirements of paragraph Class I Work Procedures, Class I asbestos work shall be performed using the control methods identified in the subparagraphs below.

##### 3.6.5.1 Negative Pressure Enclosure (NPE) System

The system shall provide at least 4 air changes per hour inside the containment. The local exhaust unit equipment shall be operated 24 hours per day until the containment is removed, and shall be leak-proof to the filter and equipped with HEPA filters. Air movement shall be directed away from the employees and toward a HEPA filtration device. The NPE shall be smoke tested for leaks at the beginning of each shift. Local exhaust equipment shall be sufficient to maintain a minimum pressure differential of minus 0.02 inch of water column relative to adjacent, unsealed areas. Pressure differential shall be monitored continuously, 24 hours per day, with an automatic manometric recording instrument. Pressure differential recordings shall be provided daily on the same day collected. Readings shall be reviewed by the Contractor's Designated Competent Person and IH prior to submittal. The Contracting Officer shall be notified immediately if the pressure differential falls below the prescribed minimum. The building ventilation system shall not be used as the local exhaust system for the regulated area. The local exhaust system shall terminate outdoors unless an alternate arrangement is allowed by the Contract Officer. All filters used shall be new at the beginning of the project and shall be periodically changed as necessary and disposed of as ACM waste.

##### 3.6.5.2 Wrap and Cut Operation

Prior to cutting boiler/tank, the asbestos-containing insulation shall be wrapped with polyethylene and securely sealed with duct tape to prevent asbestos becoming airborne as a result of the cutting process.

### 3.6.6 Abatement of Asbestos Fibrous Duct, Debris and Contaminated Soil in Crawl Space

Asbestos contaminated debris shall be removed throughout the crawl space. Debris includes but is not limited to loose sections of thermal system insulation, metal conduit, wood studs and boards, electrical cords, and plastic sheeting. Asbestos contaminated soil shall be removed from areas to a minimum depth of 2 inches. Soil shall be thoroughly dampened with amended water and then removed by manual shoveling into labeled containers.

The workers shall be closely monitored for heat exhaustion. The minimum ventilation shall be 8 air changes per hour through a local exhaust HEPA system. Remove fibrous asbestos ducts penetrating wood subfloor in crawl space. Thoroughly dampen duct with amended water. Remove in manageable sections. Dispose of all generated waste as asbestos. The Contractor's Designated IH shall perform visual inspection to verify that all asbestos debris has been removed and shall collect bulk soil samples and have analyzed using Polarized Light Microscopy (PLM). The Contractor shall clean and remove soil until laboratory results of bulk samples indicate asbestos has not been detected. Resampling and recleaning will be performed by the Contractor at no additional cost to government.

### 3.6.7 Abatement of Asbestos Containing Debris in Attic

Asbestos containing debris in attic shall be removed utilizing a full containment work area. The Contractor shall remove 8 cubic feet of debris around every location where asbestos thermal system insulation is visually identified throughout attic space. For bidding purposes the Contractor shall assume 125 locations. Debris includes but is not limited to loose sections of thermal system insulation, metal conduit, wood studs and boards, electrical cords, and fiberglass attic insulation. Debris shall be misted with amended water and then removed by manual methods and placed into 6-mil plastic bags. The Contractor's Designated IH shall perform visual inspection to verify that all asbestos debris has been removed and collect bulk soil samples and analyzed using Polarized Light Microscopy (PLM). The Contractor shall clean and remove soil until laboratory results of bulk samples indicate asbestos has not been detected. Resampling and recleaning will be performed by the Contractor at no additional cost to government.

### 3.6.8 Abatement of Asbestos Containing Boiler Insulation

Boiler Insulation: Written approval shall be obtained from the Contracting Officer before start of work on tanks and boiler breeching. The Contracting Officer will ensure that boiler has been valved off or shut down and allowed a sufficient amount of time to cool down. Insulation shall be sprayed with a mist of amended water or removal encapsulant. Amended water or removal encapsulant shall be allowed to saturate material to substrate. Bands or wires holding breeching or insulation to equipment shall be cut. Cover jackets shall be slit at seams, and sections removed and hand-placed in a polyethylene disposable bag. Exposed surfaces shall be continuously sprayed with amended water to minimize airborne dust. Insulation on boiler shall not be allowed to drop to the floor. Residue shall be removed from boiler surfaces. A water stream shall be used to dislodge insulation in joints or irregular spaces that cannot be reached with tools. A penetrating encapsulant shall be sprayed on all exposed

tank, boiler and boiler breeching surfaces.

### 3.6.9 Cleaning After Asbestos Removal

After completion of all asbestos removal work, surfaces from which ACM has been removed shall be wet wiped or sponged clean, or cleaned by some equivalent method to remove all visible residue. Run-off water shall be collected and filtered through a dual filtration system. A first filter shall be provided to remove fibers 20 micrometers and larger, and a final filter provided that removes fibers 5 micrometers and larger. After the gross amounts of asbestos have been removed from every surface, remaining visible accumulations of asbestos on all surfaces shall be collected using plastic shovels, rubber squeegees, rubber dustpans, and HEPA vacuum cleaners as appropriate to maintain the integrity of the regulated area. When TSI and surfacing material has been removed, workmen shall use HEPA vacuum cleaners to vacuum every surface. Surfaces or locations which could harbor accumulations or residual asbestos dust shall be checked after vacuuming to verify that no asbestos-containing material remains; and shall be re-vacuumed as necessary to remove the ACM.

### 3.7 FINAL CLEANING AND VISUAL INSPECTION

Upon completion of abatement, the regulated area shall be cleaned by collecting, packing, and storing all gross contamination. A final cleaning shall be performed using HEPA vacuum and wet cleaning of all exposed surfaces and objects in the regulated area. Upon completion of the cleaning, the Contractor shall conduct a visual pre-inspection of the cleaned area in preparation for a final inspection before final air clearance monitoring and recleaning, as necessary. Upon completion of the final cleaning, the Contractor and the Contracting Officer shall conduct a final visual inspection of the cleaned regulated area in accordance with ASTM E 1368 and document the results on the Final Cleaning and Visual Inspection. If the Contracting Officer rejects the clean regulated area as not meeting final cleaning requirements, the Contractor shall reclean as necessary and have a follow-on inspection conducted with the Contracting Officer. Recleaning and follow-up reinspection shall be at the Contractor's expense.

### 3.8 LOCKDOWN

Prior to removal of plastic barriers and after clean-up of gross contamination and final visual inspection, a post removal (lockdown) encapsulant shall be spray applied to ceiling, walls, floors, and other surfaces in the regulated area.

### 3.9 EXPOSURE ASSESSMENT AND AIR MONITORING

#### 3.9.1 General Requirements For Exposure

Exposure assessment, air monitoring and analysis of airborne concentration of asbestos fibers shall be performed in accordance with 29 CFR 1926, Section .1101, the Contractor's air monitoring plan, and as specified. Personal exposure air monitoring (collected at the breathing zone) that is representative of the exposure of each employee who is assigned to work within a regulated area shall be performed by the Contractor's Designated IH. Breathing zone samples shall be taken for at least 25 percent of the workers in each shift, or a minimum of 2, whichever is greater. Air monitoring results at the 95 percent confidence level shall be calculated as shown in Table 2 at the end of this section. The Contractor shall

provide an onsite independent testing laboratory with qualified analysts and appropriate equipment to conduct sample analyses of air samples using the methods prescribed in 29 CFR 1926, Section.1101, to include NIOSH Pub No. 84-100 Method 7400. Preabatement and abatement environmental air monitoring shall be performed by the Contractor's Designated IH and Contracting Officer's IH. Final clearance environmental air monitoring, shall be performed by the Contractor's Designated IH. Environmental and final clearance air monitoring shall be performed using NIOSH Pub No. 84-100 Method 7400 (PCM) with optional confirmation of results by NIOSH Pub No. 84-100 Method 7402 (TEM). For environmental and final clearance, air monitoring shall be conducted at a sufficient velocity and duration to establish the limit of detection of the method used at 0.005 f/cc. Confirmation of asbestos fiber concentrations (asbestos f/cc) from environmental and final clearance samples collected and analyzed by NIOSH Pub No. 84-100 Method 7400 (total f/cc) may be conducted using TEM in accordance with NIOSH Pub No. 84-100 Method 7402. When such confirmation is conducted, it shall be from the same sample filter used for the NIOSH Pub No. 84-100 Method 7400 PCM analysis. For all Contractor required environmental or final clearance air monitoring, confirmation of asbestos fiber concentrations, using NIOSH Pub No. 84-100 Method 7402, shall be at the Contractor's expense. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. Results of breathing zone samples shall be posted at the job site and made available to the Contracting Officer. The Contractor shall maintain a fiber concentration inside a regulated area less than or equal to 0.1 f/cc expressed as an 8 hour, time-weighted average (TWA) during the conduct of the asbestos abatement. If fiber concentration rises above 0.1 f/cc, work procedures shall be investigated with the Contracting Officer to determine the cause. At the discretion of the Contracting Officer, fiber concentration may exceed 0.1 f/cc but shall not exceed 1.0 f/cc expressed as an 8-hour TWA. The Contractor's workers shall not be exposed to an airborne fiber concentration in excess of 1.0 f/cc, as averaged over a sampling period of 30 minutes. Should either an environmental concentration of 1.0 f/cc expressed as an 8-hour TWA or a personal excursion concentration of 1.0 f/cc expressed as a 30-minute sample occur inside a regulated work area, the Contractor shall stop work immediately, notify the Contracting Officer, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the Contracting Officer.

### 3.9.2 Initial Exposure Assessment

The Contractor's Designated IH shall conduct an exposure assessment immediately before or at the initiation of an asbestos abatement operation to ascertain expected exposures during that operation. The assessment shall be completed in time to comply with the requirements which are triggered by exposure data or the lack of a negative exposure assessment, and to provide information necessary to assure that all control systems planned are appropriate for that operation. The assessment shall take into consideration both the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the Contractor which indicate the levels of airborne asbestos likely to be encountered on the job. For Class I asbestos work, until the employer conducts exposure monitoring and documents that employees on that job will not be exposed in excess of PELs, or otherwise makes a negative exposure assessment, the Contractor shall presume that employees are exposed in excess of the PEL-TWA and PEL-Excursion Limit.

### 3.9.3 Negative Exposure Assessment

The Contractor shall provide a negative exposure assessment for the specific asbestos job which will be performed. The negative exposure assessment shall be provided prior to the initiation of the project and conform to the following criteria:

- a. **Objective Data:** Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the PEL-TWA and PEL-Excursion Limit under those work conditions having the greatest potential for releasing asbestos.
- b. **Prior Asbestos Jobs:** Where the Contractor has monitored prior asbestos jobs for the PEL and the PEL-Excursion Limit within 12 months of the current job, the monitoring and analysis were performed in compliance with asbestos standard in effect; the data were obtained during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the Contractor's current operations; the operations were conducted by employees whose training and experience are no more extensive than that of employees performing the current job; and these data show that under the conditions prevailing and which will prevail in the current workplace, there is a high degree of certainty that the monitoring covered exposure from employee exposures will not exceed the PEL-TWA and PEL-Excursion Limit.
- c. **Initial Exposure Monitoring:** The results of initial exposure monitoring of the current job, made from breathing zone air samples that are representative of the 8-hour PEL-TWA and 30-minute short-term exposures of each employee. The monitoring covered exposure from operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

### 3.9.4 Independent Environmental Monitoring

The Government has retained an independent air monitoring firm to perform pre-abatement during abatement final clearance air monitoring. The air monitoring contractor has been provided a copy of the contract that includes this abatement work. The abatement contractor will provide the air monitoring contractor with an up-to-date copy of the accepted Asbestos Hazard Abatement Plan, Accident Prevention Plan and pertinent detailed drawings. The air monitoring contractor is required to comply with the abatement contractor's safety and health requirements. The abatement contractor will coordinate all onsite activities with the air monitoring contractor, the COR, and other affected parties as directed by the COR. The abatement contractor will provide the air monitoring contractor with an up-to-date schedule of abatement contractor work activities. The air monitoring contractor will coordinate with the abatement contractor and the COR during the performance Government required air monitoring. The abatement contractor is responsible for performing exposure assessment and personal air monitoring of abatement contractor's work. The air monitoring contractor is responsible for performing these tasks for its employee.

### 3.9.5 Preabatement Environmental Air Monitoring

Preabatement environmental air monitoring shall be established 1 day prior to the masking and sealing operations for each regulated area to determine background concentrations before abatement work begins. As a minimum, preabatement air samples shall be collected using NIOSH Pub No. 84-100 Method 7400, PCM at these locations: outside the building; inside the building, but outside the regulated area perimeter; and inside each regulated work area. One sample shall be collected for every 2000 square feet of floor space. At least 2 samples shall be collected outside the building: at the exhaust of the HEPA unit; and downwind from the abatement site. The PCM samples shall be analyzed within 24 hours; and if any result in fiber concentration greater than 0.01 f/cc, asbestos fiber concentration shall be confirmed using NIOSH Pub No. 84-100 Method 7402 (TEM).

### 3.9.6 Environmental Air Monitoring During Abatement

Until an exposure assessment is provided to the Contracting Officer, environmental air monitoring shall be conducted at locations and frequencies that will accurately characterize any evolving airborne asbestos fiber concentrations. The assessment shall demonstrate that the product or material containing asbestos minerals, or the abatement involving such product or material, cannot release airborne asbestos fibers in concentrations exceeding 0.01 f/cc as a TWA under those work conditions having the greatest potential for releasing asbestos. The monitoring shall be at least once per shift at locations including, but not limited to, close to the work inside a regulated area; preabatement sampling locations; outside entrances to a regulated area; close to glovebag operations; representative locations outside of the perimeter of a regulated area; inside clean room; and at the exhaust discharge point of local exhaust system ducted to the outside of a containment (if used). If the sampling outside regulated area shows airborne fiber levels have exceeded background or 0.01 f/cc, whichever is greater, work shall be stopped immediately, and the Contracting Officer notified. The condition causing the increase shall be corrected. Work shall not restart until authorized by the Contracting Officer.

### 3.9.7 Final Clearance Air Monitoring

Prior to conducting final clearance air monitoring, the Contractor and the Contracting Officer shall conduct a final visual inspection of the regulated area where asbestos abatement has been completed. Final clearance air monitoring shall not begin until acceptance of the Contractor's final cleaning by the Contracting Officer. The Contractor's Designated IH shall conduct final clearance air monitoring using aggressive air sampling techniques as defined in EPA 560/5-85-024 or as otherwise required by federal or state requirements. The sampling and analytical method used will be NIOSH Pub No. 84-100 Method 7400 (PCM) and Table 3 with confirmation of results by NIOSH Pub No. 84-100 Method 7402 (TEM), and the EPA TEM Method specified at 40 CFR 763 and Table 4.

#### 3.9.7.1 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH Pub No. 84-100 Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, shall be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) shall be confirmed from that same filter using NIOSH Pub No. 84-100 Method 7402 (TEM) at

Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning shall be repeated. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria shall be done.

### 3.9.7.2 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, the Contractor shall pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

### 3.9.8 Air-Monitoring Results and Documentation

Air sample fiber counting shall be completed and results provided within 24 hours (breathing zone samples), and hours (environmental/clearance monitoring) after completion of a sampling period. The Contracting Officer shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal and the Contractor's Designated IH. The air sampling results shall be documented on a Contractor's daily air monitoring log. The daily air monitoring log shall contain the following information for each sample:

- a. Sampling and analytical method used;
- b. Date sample collected;
- c. Sample number;
- d. Sample type: BZ = Breathing Zone (Personal), P = Preabatement, E = Environmental, C = Abatement Clearance;
- e. Location/activity/name where sample collected;
- f. Sampling pump manufacturer, model and serial number, beginning flow rate, end flow rate, average flow rate (L/min);
- g. Calibration date, time, method, location, name of calibrator, signature;
- h. Sample period (start time, stop time, elapsed time (minutes));
- i. Total air volume sampled (liters);
- j. Sample results (f/cc and S/mm square) if EPA methods are required for final clearance;
- k. Laboratory name, location, analytical method, analyst, confidence level. In addition, the printed name and a signature and date block for the Industrial Hygienist who conducted the sampling and for the Industrial Hygienist who reviewed the daily air monitoring log verifying the accuracy of the information.

### 3.10 CLEARANCE CERTIFICATION

When asbestos abatement is complete, ACM waste is removed from the regulated areas, and final clean-up is completed, the Contracting Officer

will certify the areas as safe before allowing the warning signs and boundary warning tape to be removed. After final clean-up and acceptable airborne concentrations are attained, but before the HEPA unit is turned off and the containment removed, the Contractor shall remove all pre-filters on the building HVAC system and provide new pre-filters. The Contractor shall dispose of such filters as asbestos contaminated materials. HVAC, mechanical, and electrical systems shall be re-established in proper working order. The Contractor and the Contracting Officer shall visually inspect all surfaces within the containment for residual material or accumulated debris. The Contractor shall reclean all areas showing dust or residual materials. The Contracting Officer will certify in writing that the area is safe before unrestricted entry is permitted. The Government will have the option to perform monitoring to certify the areas are safe before entry is permitted.

### 3.11 CLEANUP AND DISPOSAL

#### 3.11.1 Title to ACM Materials

ACM material resulting from abatement work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified and in accordance with applicable federal, state and local regulations.

#### 3.11.2 Collection and Disposal of Asbestos

All ACM waste shall be collected and including contaminated wastewater filters, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing, shall be collected and placed in leak-tight containers such as double plastic bags sealed double wrapped polyethylene sheet ; sealed fiberboard boxes ; or other approved containers. Waste within the containers shall be wetted in case the container is breeched. Asbestos-containing waste shall be disposed of at an EPA, state and local approved asbestos landfill off Government property. For temporary storage, sealed impermeable containers shall be stored in an asbestos waste load-out unit or in a storage/transportation conveyance (i.e., dumpster, roll-off waste boxes, etc.) in a manner acceptable to and in an area assigned by the Contracting Officer. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, state, regional, and local standards.

#### 3.11.3 Scale Weight Measurement

Scales used for measurement shall be public scales. Weighing shall be at a point nearest the work at which a public scale is available. Scales shall be standard truck scales of the beam type; scales shall be equipped with the type registering beam and an "over and under" indicator; and shall be capable of accommodating the entire vehicle. Scales shall be tested, approved and sealed by an inspector of the State of Virginia. Scales shall be calibrated and resealed as often as necessary and at least once every three months to ensure continuous accuracy. Vehicles used for hauling ACM shall be weighed empty daily at such time as directed and each vehicle shall bear a plainly legible identification mark.

#### 3.11.4 Weigh Bill and Delivery Tickets

Copies of weigh bills and delivery tickets shall be submitted to the Contracting Officer during the progress of the work. The Contractor shall furnish the Contracting Officer scale tickets for each load of ACM weighed and certified. These tickets shall include tare weight; identification

mark for each vehicle weighed; and date, time and location of loading and unloading. Tickets shall be furnished at the point and time individual trucks arrive at the worksite. A master log of all vehicle loading shall be furnished for each day of loading operations. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified weigh bills and/or certified tickets and manifests of all ACM actually disposed by the Contractor for this contract.

#### 3.11.5 Asbestos Waste Shipment Record

The Contractor shall complete and provide the Contracting Officer final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR 61, Subpart M and other required state waste manifest shipment records, within 3 days of delivery to the landfill.

Each Waste Shipment Record shall be signed and dated by the Contractor , the waste transporter and disposal facility operator.

TABLE 1

INDIVIDUAL WORK TASK DATA ELEMENTS

Sheet \_\_\_\_\_ of \_\_\_\_\_

There is a separate data sheet for each individual work task.

1. WORK TASK DESIGNATION NUMBER \_\_\_\_\_
2. LOCATION OF WORK TASK \_\_\_\_\_  
\_\_\_\_\_
3. BRIEF DESCRIPTION OF MATERIAL TO BE ABATED: \_\_\_\_\_  
\_\_\_\_\_
  - a. Type of Asbestos \_\_\_\_\_
  - b. Percent asbestos content \_\_\_\_\_%
4. ABATEMENT TECHNIQUE TO BE USED \_\_\_\_\_
5. OSHA ASBESTOS CLASS DESIGNATION FOR WORK TASK \_\_\_\_\_
6. EPA NESHAP FRIABILITY DESIGNATION FOR WORK TASK  
Friable \_\_\_\_\_ Nonfriable Category I \_\_\_\_\_  
Nonfriable Category II \_\_\_\_\_
7. FORM \_\_\_\_\_ and CONDITION OF ACM: GOOD \_\_\_\_\_ FAIR \_\_\_\_\_ POOR \_\_\_\_\_
8. QUANTITY: METERS \_\_\_\_\_, SQUARE METERS \_\_\_\_\_
- 8a. QUANTITY: LINEAR FT. \_\_\_\_\_, SQUARE FT. \_\_\_\_\_
9. RESPONSE ACTION DETAIL SHEET NUMBER FOR WORK TASK \_\_\_\_\_
10. SET-UP DETAIL SHEET NUMBERS  
FOR WORK TASK \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_.

NOTES:

- (1) Numeric sequence of individual work tasks (1,2,3,4, etc.) for each regulated area. Each category of EPA friability/OSHA class has a separate task.
- (2) Specific location of work (building, floor, area, e.g., Building 1421, 2nd Floor, Rm 201)
- (3) A description of material to be abated (example: horizontal pipe, cement wall panels, tile, stucco, etc.) type of asbestos (chrysotile, amosite, crocidolite, etc.); and % asbestos content.
- (4) Technique to be used: Removal = REM; Encapsulation = ENCAP; Encasement = ENCAS; Enclosure = ENCL; Repair = REP.
- (5) Class designation: Class I, II, III, or IV (OSHA designation).
- (6) Friability of materials: Check the applicable EPA NESHAP friability designation.
- (7) Form: Interior or Exterior Architectural = IA or EA; Mechanical/Electrical = ME.  
Condition: Good = G; Fair = F; Poor = P.
- (8) Quantity of ACM for each work task in meters or square meters.
- (8a) Quantity of ACM for each work task in linear feet or square feet.
- (9) Response Action Detail Sheet specifies the material to be abated and the methods to be used. There is only one Response Action Detail Sheet for each abatement task.
- (10) Set-up Detail Sheets indicate containment and control methods used in support of the response action (referenced in the selected Response Action Detail Sheet).

TABLE 2

FORMULA FOR CALCULATION OF THE 95 PERCENT CONFIDENCE LEVEL  
(Reference: NIOSH 7400)

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$$\text{Fibers/cc(01.95 percent CL)} = X + [(X) * (1.645) * (CV)]$$

Where:  $X = ((E)(AC))/((V)(1000))$

$$E = ((F/Nf) - (B/Nb))/Af$$

CV = The precision value; 0.45 shall be used unless the analytical laboratory provides the Contracting Officer with documentation (Round Robin Program participation and results) that the laboratory's precision is better.

AC = Effective collection area of the filter in square millimeters

V = Air volume sampled in liters

E = Fiber density on the filter in fibers per square millimeter

F/Nf = Total fiber count per graticule field

B/Nb = Mean field blank count per graticule field

Af = Graticule field area in square millimeters

$$\text{TWA} = C1/T1 + C2/T2 = Cn/Tn$$

Where: C = Concentration of contaminant

T = Time sampled.

TABLE 3  
 NIOSH METHOD 7400  
 PCM ENVIRONMENTAL AIR SAMPLING PROTOCOL (NON-PERSONAL)

Sample Location	Minimum No. of Samples	Filter Pore Size (Note 1)	Min. Vol. (Note 2) (Liters)	Sampling Rate (liters/min.)
Inside Abatement Area	0.5/140 Square Meters (Notes 3 & 4)	0.45 microns	3850	2-16
Each Room in 1 Abatement Area Less than 140 Square meters		0.45 microns	3850	2-16
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

## Notes:

1. Type of filter is Mixed Cellulose Ester.
2. Ensure detection limit for PCM analysis is established at 0.005 fibers/cc.
3. One sample shall be added for each additional 140 square meters. (The corresponding I-P units are 5/1500 square feet).
4. A minimum of 5 samples are to be taken per abatement area, plus 2 field blanks.

TABLE 4

EPA AHERA METHOD: TEM AIR SAMPLING PROTOCOL

Location Sampled	Minimum No. of Samples	Filter Pore Size	Min. Vol. (Liters)	Sampling Rate (liters/min.)
Inside Abatement Area	5	0.45 microns	1500	2-16
Outside Abatement Area	5	0.45 microns	1500	2-16
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

## Notes:

1. Type of filter is Mixed Cellulose Ester.
2. The detection limit for TEM analysis is 70 structures/square mm.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME \_\_\_\_\_ CONTRACT NO. \_\_\_\_\_
PROJECT ADDRESS \_\_\_\_\_
CONTRACTOR FIRM NAME \_\_\_\_\_
EMPLOYEE'S NAME \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,
(Print) (Last) (First) (MI)

Social Security Number: \_\_\_\_\_-\_\_\_\_\_-\_\_\_\_\_

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH TYPES OF LUNG DISEASE AND CANCER. IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NONSMOKING PUBLIC.

Your employer's contract for the above project requires that you be provided and you complete formal asbestos training specific to the type of work you will perform and project specific training; that you be supplied with proper personal protective equipment including a respirator, that you be trained in its use; and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you. The Contractor's Designated Industrial Hygienist will check the block(s) for the type of formal training you have completed. Review the checked blocks prior to signing this certification.

FORMAL TRAINING:

\_\_\_\_\_ a. For Competent Persons and Supervisors: I have completed EPA's Model Accreditation Program (MAP) training course, "Contractor/Supervisor", that meets this State's requirements.

b. For Workers:

\_\_\_\_\_ (1) For OSHA Class I work: I have completed EPA's MAP training course, "Worker", that meets this State's requirements.

\_\_\_\_\_ (2) For OSHA Class II work (where there will be abatement of more than one type of Class II materials, i.e., roofing, siding, floor tile, etc.): I have completed EPA's MAP training course, "Worker", that meets this State's requirements.

\_\_\_\_\_ (3) For OSHA Class II work (there will only be abatement of one type of Class II material):

\_\_\_\_\_ (a) I have completed an 8-hour training class on the elements of 29 CFR 1926, Section .1101(k)(9)(viii), in addition to the specific work practices and engineering controls of 29 CFR 1926, Section .1101(g) and hands-on training.

\_\_\_\_\_ (b) I have completed EPA's MAP training course, "Worker", that meets this State's requirements.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

\_\_\_\_\_ c. Workers, Supervisors and the Designated Competent Person: I have completed annual refresher training as required by EPA's MAP that meets this State's requirements.

PROJECT SPECIFIC TRAINING:

\_\_\_\_\_ I have been provided and have completed the project specific training required by this Contract. My employer's Designated Industrial Hygienist and Designated Competent Person conducted the training.

RESPIRATORY PROTECTION:

\_\_\_\_\_ I have been trained in accordance with the criteria in the Contractor's Respiratory Protection program. I have been trained in the dangers of handling and breathing asbestos dust and in the proper work procedures and use and limitations of the respirator(s) I will wear. I have been trained in and will abide by the facial hair and contact lens use policy of my employer.

RESPIRATOR FIT-TEST TRAINING:

\_\_\_\_\_ I have been trained in the proper selection, fit, use, care, cleaning, maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's Respiratory Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-check upon donning negative pressure respirators each time.

MEDICAL EXAMINATION:

\_\_\_\_\_ I have had a medical examination within the last twelve months which was paid for by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing personal protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's Industrial Hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that there:

\_\_\_\_\_ were no limitations to performing the required work tasks.  
\_\_\_\_\_ were identified physical limitations to performing the required work tasks.

Date of the medical examination \_\_\_\_\_

Employee Signature \_\_\_\_\_ date \_\_\_\_\_

Contractor's Industrial Hygienist Signature \_\_\_\_\_ date \_\_\_\_\_

-- End of Section --

## SECTION 13281A

LEAD HAZARD CONTROL ACTIVITIES  
03/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |   |
|-------------|---|
| ASTM E 1553 | (1993) Practice for Collection of Airborne Particulate Lead During Abatement and Construction Activities  |
| ASTM E 1613 | (1999) Standard Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption (GFAAS) Techniques |
| ASTM E 1644 | (1998) Practice for Hot Plate Digestion of Dust Wipe Samples for the Determination of Lead  |
| ASTM E 1728 | (1999) Field Collection of Settled Dust Samples Using Wipe Sampling Methods for Lead Determination by Atomic Spectrometry Techniques  |
| ASTM E 1729 | (1999) Field Collection of Dried Paint Samples for Lead Determination by Atomic Spectrometry Techniques   |
| ASTM E 1741 | (2000) Preparation of Airborne Particulate Lead Samples Collected During Abatement and Construction Activities for Subsequent Analysis by Atomic Spectrometry   |
| ASTM E 1792 | (1996a) Wipe Sampling Materials for Lead in Surface Dust  |

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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| NFPA 701 | (1999) Methods of Fire Tests for Flame-Resistant Textiles and Films |
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## NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

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| NIOSH Pub No. 84-100 | (1984; Supple 1985, 1987, 1988 & 1990) NIOSH Manual of Analytical Methods |
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## U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual

## U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

HUD 6780 (1995; Errata Aug 1996; Rev Ch. 7 - 1997) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

24 CFR 35 Lead-Based Paint Poisoning Prevention in Certain Residential Structures

29 CFR 1910 Occupational Safety and Health Standards

29 CFR 1926 Safety and Health Regulations for Construction

40 CFR 745 Lead-Based Paint Poisoning Prevention in Certain Residential Structures

## 1.2 DEFINITIONS

- a. Lead Hazard Control Activity - Any construction work where a worker may be occupationally exposed to lead and procedures have to be followed to assure that: 1). Lead inside the lead hazard control area is cleaned up to appropriate levels and 2). Lead dust does not disperse outside the lead hazard control area at unacceptable levels.
  
- g. Group 1 Tasks - Activities performed on surfaces covered with paint at or above the laboratory's minimum detection limit for lead. The following activities are considered Group 1 Tasks and require appropriate protective measures in accordance with 29 CFR 1926.62: manual demolition, manual scraping, manual sanding, heat applications, general cleanup, power tool cleaning with dust collection system, and spray paint with lead-based paints.
  
- h. Group 2 Tasks - Activities performed on surfaces covered with paint at or above the laboratory's minimum detection limit for lead. The following activities are considered Group 2 Tasks and require appropriate protective measures in accordance with 29 CFR 1926.62: lead burning, using lead-containing mortar, power tool cleaning without dust collection system, rivet blasting, cleanup activities where dry expendable abrasives are used, and movement and removal of abrasive blasting enclosures.
  
- i. Group 3 Tasks - Activities performed on surfaces covered with paint at or above the laboratory's minimum detection limit for

lead. The following activities are considered Group 3 Tasks and require appropriate protective measures in accordance with 29 CFR 1926.62: abrasive blasting welding, cutting and burning on steel structures.

### 1.3 DESCRIPTION OF WORK

The work covered by this section includes work tasks, on the individual work task data sheets at the end of this section, and the precautions specified in this section for the protection of workers, building occupants and the environments.

Work covered by this section includes but is not limited to Group 1, Group 2, and Group 3 Tasks, Trigger Operations, as outlined in 29 CFR 1926.62, performed on paint containing lead above the laboratory's minimum detection limit or on materials coated with paint containing lead, located at Buildings 18, 20, 21, and the bunker at Langley Air Force Base, Virginia. The Contractor shall assumed that all painted surfaces scheduled demolition/renovation contains lead concentrations above the laboratory's minimum detection limit.

The Contractor is responsible for developing a project approach by coordinating the requirements of this specification with the various subcontractors performing other components of the contract in order to execute the work. The work techniques selected by the Contractor and identified in the Lead Hazard Control Plan will determine the abatement measures necessary, if any. The project approach shall be based on historical data and experience with similar scope projects. The scope of work includes disposal of materials generated from execution of the contract

#### 1.3.1 Protection of Existing Areas To Remain

All project work including, but not limited to, lead hazard work, storage, transportation, and disposal shall be performed without damaging or contaminating adjacent work and areas. Where such work or areas are damaged or contaminated, the Contractor shall restore work and areas to the original condition at no additional cost to the Government.

#### 1.3.2 Coordination with Other Work

The contractor shall coordinate lead hazard control activities with work being performed in adjacent areas. Coordination procedures shall be explained in the Contractor's Accident Prevention Plan and shall describe how the Contractor will prevent lead exposure to other contractors and/or Government personnel performing work unrelated to lead hazard control activities.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Materials and Equipment  
Expendable Supplies

A description of the materials, equipment and expendable supplies required; including Material Safety Data Sheets (MSDSs) for material brought onsite to perform the work.

Qualifications; G

A report providing evidence of qualifications and designating responsibilities for personnel and laboratories.

#### SD-06 Test Reports

Licences, Permits, and Notifications; G,  
Accident Prevention Plan (APP); G,

A report describing how the Contractor will protect workers, building occupants, and building contents while performing lead hazard control activities; and how project clearance will be performed.

Sampling and Analysis; G,

A log of the analytical results required for the sampling. The log shall be kept current.

Clearance Report; G,

Report prepared by the QSHP.

### 1.5 QUALIFICATIONS

#### 1.5.1 Qualifications and Organization Report

The Contractor shall furnish a qualification and organization report. The report shall describe the qualifications of the qualified safety and health professional (QSHP), onsite safety and health supervisor (OSHS), labor staff and the independent risk assessor. The report shall include an organization chart showing the Contractor's personnel by name and title and project specific responsibilities and authorities. The report shall describe the qualifications of the laboratories selected for this project. The report shall be signed by the Contractor and the qualified safety and health professional to indicate that all personnel and laboratories comply with certification and experience requirements of this section and that project personnel have been given the authority to complete the tasks assigned to them.

#### 1.5.2 Personnel and Subcontractor Responsibilities and Qualifications

##### 1.5.2.1 Qualified Safety and Health Professional (QSHP)

The QSHP shall be responsible for development of project specific requirements in the Accident Prevention Plan (APP); supervise implementation of the APP requirements; visit the site as needed to verify effectiveness of the APP and to coordinate resolution of unknown situations that may develop as the work progresses; be available to provide consultation to the Onsite Safety and Health Supervisor (OSHS); review sampling and analytical results to evaluate occupational exposure levels, verify effectiveness of controls and determine if clearance requirements

have been met. The QSHP shall have demonstrable experience with the implementation of occupational safety and health regulations. The QSHP shall be certified, and hold a current license, by the Commonwealth of Virginia as a Lead Risk Assessor, Lead Project Designer, and Lead Supervisor.

#### 1.5.2.2 Lead Hazard Control Workers

Lead Hazard Control workers shall be responsible for performing the labor necessary to complete the lead hazard control activities required in this contract. Workers shall be certified, and hold a current license, by the Commonwealth of Virginia as a Lead Worker.

#### 1.5.2.3 Independent Certified Risk Assessor

The independent Certified Risk Assessor shall be a subcontractor to the prime Contractor on the project. The risk assessor shall be responsible to perform the sampling and evaluating the analytical data to verify clearance levels have been achieved. The independent risk assessor shall sign the clearance report indicating clearance requirements for the contract have been met. The independent Certified Risk Assessor shall be certified, and hold a current license, by the Commonwealth of Virginia as a Lead Risk Assessor.

#### 1.5.2.4 Testing Laboratories

The laboratory selected to perform analysis on paint chip, soil or dust wipe samples shall be accredited by EPA's National Lead Laboratory Accreditation Program (NLLAP). The laboratory selected perform analysis on worker exposure (industrial hygiene) samples shall be in the American Industrial Hygiene Association's Industrial Hygiene Laboratory Accreditation Program (IHLAP) and shall be successfully participating in the Proficiency Analytical Testing (PAT) program for lead.

#### 1.5.2.5 Blood Lead Testing

The laboratory selected to perform analysis on worker blood samples shall be approved by OSHA and meet the requirements contained in [http://www.osha-slc.gov/OCIS/toc\\_bloodlead.html](http://www.osha-slc.gov/OCIS/toc_bloodlead.html).

#### 1.5.2.6 Disposal Facility and Transporter

The Contractor shall furnish written evidence that the landfill to be used is approved for lead disposal by USEPA and state and local requirements. Copies of any required signed agreements between the Contractor (including subcontractors and transporters) and the lead disposal facility shall be provided.

### 1.6 REGULATORY REQUIREMENTS

In addition to the detailed requirements of this specification, work shall be performed in accordance with requirements of EM 385-1-1 and applicable regulations including, but not limited to 29 CFR 1910, 29 CFR 1926, especially Section .62, and the accepted Accident Prevention Plan with Appendices. Matters of interpretation of the standards shall be resolved to the satisfaction of and with the concurrence of, the Contracting Officer before starting work. Where these requirements vary, the most stringent shall apply.

## 1.7 ACCIDENT PREVENTION PLAN (APP)

### 1.7.1 APP Content and Organization

The Contractor's Accident Prevention Plan shall be organized into 5 parts, consisting of the overall plan and 4 appendices. The overall plan shall address each element in Appendix A of EM 385-1-1 in project specific detail. The elements are: a. Signature Sheet, b. Background Information, c. Statement of Safety and Health Policy, d. Responsibilities and Lines of Authorities, e. Subcontractors and Suppliers, f. Training, g. Safety and Health Inspections, h. Safety and Health Expectations, Incentive Programs and Compliance, i. Accident Reporting, j. Medical Support, k. Corporate Plans and Programs required by this contract, (HAZCOM, Respiratory Protection).

#### 1.7.1.1 Lead Hazard Control Plan Appendix

The Lead Hazard Control Appendix shall address occupational exposure issues and shall describe the procedures to be followed to protect employees from lead hazards while performing lead hazard control activities. Each of the following elements shall be addressed in the lead hazard control appendix:

- a. The location and a brief description of each work activity that will emit lead into the workplace atmosphere. A description of any components containing lead shall be included and keyed to the project drawings.
- b. Description of equipment and materials, controls, crew size, worker responsibilities, and operating and maintenance procedures.
- c. Description and sketch of the Lead Hazard Control Areas, including decontamination areas.
- d. Description of the specific lead control methods and procedures to protect workers and other onsite contractors from lead exposure.
- e. Technologic equipment used to keep occupational exposure below the Permissible Exposure Limit and minimize worker exposure to lead (i.e., HEPA-filtered vacuum equipment/cleaners, special negative air enclosure equipment and supplies, etc.).
- f. Worker Exposure Assessment including methods and procedures to monitor and document worker exposure to lead. Worker exposure monitoring shall be broken into two parts in the plan. Part A: Initial Determination. The Contractor shall describe worker monitoring (if performed for the "initial determination" described in 29 CFR 1926 (.62) (d). Monitoring for the initial determination may be omitted from the plan if the Contractor has sufficient proof from previous operations as specified in 29 CFR 1926 (.62) (d)(3)(iii) and (iv) that workers will not be exposed over the action level. The Contractor shall substitute objective proof of action level compliance in Part A if "initial determination" monitoring is omitted. Part B: Continued Exposure Monitoring. Worker exposure monitoring after the initial lead exposure determination has been made.
- g. Work Practices Program describing the protective clothing to be used to protect workers from lead exposure, house keeping procedures employed to minimize spread on lead contamination in the

lead hazard control area, hygiene facilities and practices used to prevent workers from inadvertent ingestion of lead.

- h. Administrative Control Procedures, to be used as a last resort, to limit worker exposure to lead. The worker rotation schedule to be employed, should engineering or personal protective equipment precautions fail to be effective, shall be described. This element of the plan shall be omitted if administrative controls will not be used.
- i. Medical Surveillance practices and procedures used to monitor worker exposure to lead and to assure fitness for wearing respiratory protection devices.
- j. Worker training meeting the requirements of 29 CFR 1926 Sections (.62) and (.59) to assure workers understand hazard associated with working with lead and how to protect themselves.
- k. Security: Locked security area for each lead hazard control area. A log book shall be kept documenting entry into and out of the lead hazard control area. Entry into lead hazard control areas shall only be by personnel authorized by the Contractor and the Contracting Officer. Persons entering control areas shall be trained, medically evaluated, and equipped with personal protective equipment required for the specific control area to be entered.

#### 1.7.1.2 Activity Hazard Analyses Appendix

An Activity Hazard Analysis (AHA) shall be prepared for each work task data element specified on the individual work task data element sheets at the end of this section. The AHA shall be submitted to the Contracting Officer prior to beginning specified work. Format shall be in accordance with EM 385-1-1, figure 1-1. The AHA shall be continuously reviewed and modified, when appropriate, to address changing conditions or operations. Each accepted AHA shall be appended to and become part of the APP.

#### 1.7.1.3 Clearance Plan Appendix

The Contractor shall develop a Clearance Plan describing practices and procedures used to assure that lead hazard control activities are complete and that lead contamination within the lead hazard control area comply with final clearance levels or visual clearance criteria. Sampling and analysis procedures used to document project completion and clearance goals shall be explained in the Clearance Plan Appendix.

### 1.8 PRE-CONSTRUCTION SAFETY CONFERENCE

#### 1.8.1 Conference General Requirements

The Contractor and the QSHP shall attend a pre-construction safety conference prior to starting work. Items required to be submitted shall be reviewed for completeness, and where specified, for acceptance. Details of the APP shall be revised to correct any deficiencies, and resubmitted for acceptance. Onsite work shall not begin until the APP has been accepted, unless otherwise authorized by the Contracting Officer. One copy of the APP shall be maintained in the Contractor's jobsite file, and a second copy shall be posted where it will be accessible to personnel on the site. As work proceeds, the APP shall be adapted to new situations and conditions. Changes to the APP shall be made by the QSHP with acceptance by the

Contracting Officer. Should an unforeseen hazard become evident during performance of the work, the QSHP shall inform the Contracting Officer, both verbally and in writing, for immediate resolution. In the interim, the QSHP shall take necessary action to re-establish and maintain safe working conditions; and to safeguard onsite personnel, visitors, the public, and the environment. Disregard for provisions of this specification, or the accepted APP, shall be cause for stopping of work until the matter is rectified.

#### 1.8.2 Preparatory Inspection Meeting

The Contractor shall arrange and hold a preparatory inspection meeting to review completeness and adequacy of the APP immediately prior to beginning each phase of work.

#### 1.9 MEDICAL SURVEILLANCE REQUIREMENTS

The Contractor shall comply with the following medical surveillance requirements:

- a. The Contractor shall make every attempt to keep occupational exposure to lead on this project below the action level of 30 micrograms/cubic meter defined in 29 CFR 1926 (.62). If it is not possible, and if occupational exposures could possibly exceed the action level for 30 or more days per year, the Contractor shall institute a medical surveillance program. The program shall meet the examination frequency and content requirements specified in paragraph (j)(1), (j)(2) and (j)(3) of 29 CFR 1926 (.62). Medical removal as specified in paragraph (k) of 29 CFR 1926 (.62), if necessary, shall be at the Contractor's expense.
- b. Medical surveillance and biological monitoring shall be in compliance with 29 CFR 1926 (.62) (g) and (j). Initial biological monitoring shall be performed on lead hazard control workers prior to assignment to the project. Workers shall not be assigned to the project if results indicate a need for restricted activities.
- c. All lead hazard control workers shall pass the medical examinations necessary to be approved by the occupational physician to wear respiratory protection on this project. Occupational physician's approval shall be given prior to assignment to the project.

#### 1.10 RESPIRATORY PROTECTION PROGRAM

The Contractor shall have a written respiratory protection program and shall be fully capable of implementing the requirement of the respiratory protection program on this project. The respiratory protection program shall meet the requirements of 29 CFR 1926 (.62) and 29 CFR 1910 (.134). Project specific respiratory protection requirements shall be included in the lead hazard control plan appendix of the Contractor's accident prevention plan.

#### 1.11 LICENCES, PERMITS AND NOTIFICATIONS

The Contractor shall certify in writing to the Regional Office of the EPA, state's environmental protection agency responsible for lead hazard activities, and the Contracting Officer at least 20 days prior to the commencement of work that licenses, permits and notifications have been obtained. The Contractor is responsible for all associated fees or costs

incurred in obtaining the licenses, permits and notifications.

## 1.12 TRAINING

### 1.12.1 OSHA Training Requirements

All Contractor personnel and/or subcontractors performing or responsible for onsite oversight of lead hazard control activities shall meet the following training requirements.

- a. Content of 29 CFR 1926 (.62) and its appendices.
- b. How operations could result in exposure over the action level.
- c. Purpose, selection, fitting, use and limitations of respirators.
- d. Purpose and description of the medical surveillance program.
- e. Use of engineering controls and good work practices to limit occupational exposure to lead.
- f. Implementation of the lead hazard control plan appendix of the accident prevention plan.
- g. Medical supervision for the use of chelating agents.
- h. Employee right of access to medical surveillance records as specified in 29 CFR 1910 (.20).

### 1.12.2 Qualified Safety and Health Professional

The qualified safety and health professional shall meet the training requirements in paragraph 1.12.1 and shall meet the training, experience and authority requirements in 29 CFR 1926 (.62) to be a competent person and be trained and have the experience and education to meet 40 CFR 745 Subpart L requirements to carry the following certifications:

- a. Certified Risk Assessor
- b. Certified Project Designer
- c. Certified Supervisor

### 1.12.3 Independent Risk Assessor

The independent risk assessor shall meet the training requirements in paragraph OSHA Training Requirements, above, and shall meet the training and experience requirements in 40 CFR 745 to carry certification as a certified risk assessor.

### 1.12.4 Abatement Worker

Workers shall meet the OSHA Training Requirements specified above and the training requirements in 40 CFR 745 Subpart L to carry certification as a Certified Worker, if required.

### 1.12.5 Training Program Certification

Training to meet 40 CFR 745 Subpart L requirements shall be provided by an EPA accredited training provider and the Contractor shall provide proof in the Qualifications and Organization Report showing that personnel have

passed certification examinations for their respective disciplines, that fees for certification have been paid to the EPA (or to the state for state-run programs) and that EPA has certified the QSHP, independent risk assessor, certified workers to perform their duties.

### 1.13 SAMPLING AND ANALYSIS

#### 1.13.1 Sampling and Analytical Procedures

##### 1.13.1.1 Sampling and Analysis Methods

Analysis shall conform to NIOSH Pub No. 84-100 Method 7082, Lead, for personal sampling required by 29 CFR 1926 (.62) ASTM E 1613. Sampling shall conform to ASTM E 1553 ASTM E 1741.

##### 1.13.1.2 Paint Chip Sampling and Analysis

Sampling shall conform to ASTM E 1729 . Analysis shall conform to ASTM E 1613.

##### 1.13.1.3 Dust Wipe Materials, Sampling and Analysis

Sampling shall conform to ASTM E 1792 ASTM E 1728 ASTM E 1644 Analysis shall conform to ASTM E 1613.

#### 1.13.2 Occupational Exposure Assessment

Sampling and analytical procedures to determine compliance with the occupational exposure monitoring requirement of this section shall be described in the lead hazard control plan appendix of the Contractor's accident prevention plan. Monitoring for the initial determination may be omitted if the Contractor has sufficient proof from previous operations as specified in 29 CFR 1926 (.62) (d)(3)(iii) and (iv) that workers will not be exposed over the action level. The following occupational exposure monitoring requirements apply and shall be implemented if the requirements of 29 CFR 1926 (.62)(d)(3) (iii) and (iv) cannot be demonstrated.

- a. During Initial Monitoring the Contractor shall representatively sample employees with the greatest potential for exposure to aerosolized lead.
- b. Continued/Additional Monitoring shall meet applicable paragraphs in 29 CFR 1926 (.62)(d)(6), Frequency, after the initial determination has been made.

#### 1.13.3 Lead Hazard Control Area/Containment Monitoring

The Contractor shall perform a visual inspection once per day outside the lead hazard control area to assure visual clearance criteria are maintained while lead hazard control activities are performed. The Contractor shall clean at its own expense, and to the Contracting Officer's satisfaction, all contaminated surfaces outside the lead hazard control area, if surfaces fail visual clearance criteria.

#### 1.13.4 Clearance Monitoring

Sampling and analytical procedures to determine the clearance requirements of this section shall be described by the Contractor in the Clearance Plan Appendix of the Accident Prevention Plan.

#### 1.13.5 Waste Disposal Sampling

The Contractor shall sample the waste streams for TCLP analysis to determine waste disposal requirements in accordance with and approved landfill requirements.

#### 1.13.6 Analytical Results

The Contractor shall develop and maintain during the course of the project a log of analytical results generated by the above sampling requirements. The log shall clearly describe the reason for which the sample was taken (worker exposure, migration control, clearance) the analytical result for each sample and evaluate if the analytical result passed or failed the action levels. At a minimum, the Contractor shall include analytical results for samples required to be taken in paragraphs Occupational Exposure Assessment, Lead Hazard Control Area/Containment Monitoring, Occupancy During Work, and Clearance Monitoring specified above.

#### 1.14 CLEARANCE REQUIREMENTS

The Contractor shall describe clearance requirements for this project in the Clearance Plan Appendix of the Accident Prevention Plan.

#### 1.15 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The Contractor shall describe the PPE to be used to protect workers from

lead hazards in the Lead Hazard Control Plan Appendix of the Accident Prevention Plan. The Contractor shall furnish, at no cost to the workers, clothing for protection from lead-contaminated dust and debris. An adequate supply of these items shall be available for worker and Government personnel use. Protective clothing shall include:

- a. Coveralls : Full-body moisture permeable (breathable) disposable coveralls shall be provided to lead hazard control workers.
- b. Boots: Boots and shoes shall be provided as required by EM 385-1-1 Section 05.A.08 for workers. Boot/shoe covers shall be provided to prevent contamination of boots and shoes.
- c. Hand Protection: Gloves, etc., shall be provided as required by EM 385-1-1 Section 05.A.10 for workers.
- d. Head Protection: Hard hats shall be provided as required by 29 CFR 1910 (.135) and EM 385-1-1 Section 05.D for workers and authorized visitors.
- e. Eye and Face Protection: Eye and face protection shall be provided as required by 29 CFR 1910 (.133) and EM 385-1-1 Section 05.B for workers and authorized visitors.
- f. Respirators: NIOSH certified air-purifying respirators or filtering face pieces shall be provided for use as respiratory protection for airborne lead and for other hazardous airborne contaminants that may be encountered; as determine by the on-site safety and health supervisor. At a minimum, respirators shall be furnished to each employee required to enter a lead hazard control area where an employee exposure assessment has not yet been performed, or where monitoring data establishes the need for respiratory protection, or if requested by the employee.
- g. Respirator Cartridges/Filtering Face Pieces: Respirator cartridges shall be changed out/filtering face pieces properly disposed of when the they become sufficiently loaded with particulate matter that workers experience breathing resistance. Cartridges and filtering face pieces shall be N, R or P 100 rated to assure sufficient protection from lead exposure.

#### 1.16 HYGIENE FACILITIES

The Contractor shall describe the personal hygiene facilities to be used by the workers in the Lead Hazard Control Plan Appendix of the Accident Prevention Plan. The Contractor shall provide hygiene facilities for lead hazard control workers. Hygiene facilities shall consist of the following:

##### 1.16.1 Hand Wash Stations

The Contractor shall provide hand washing facilities for use by lead hazard control workers. Hand washing facilities shall comply with the requirements in 29 CFR 1926 (.51) (f). Faces and hands shall be washed when leaving the lead hazard control area and after each work-shift if showers are not provided.

##### 1.16.2 Change Area

The Contractor shall provide a change area to workers. The change area

shall be equipped so that contaminated work clothing and street clothes shall be stored separately to prevent cross contamination.

#### 1.16.3 Showers

Showers shall be provided if feasible and if worker exposures exceed the PEL. When provided, showers facilities shall meet the requirements of 29 CFR 1926 (.51) (f).

#### 1.16.4 Eating Area

The Contractor shall set aside an area or provide a room for taking breaks and eating lunch. This area shall be kept as free as practicable from lead contamination. Workers shall be required to follow the procedures in 29 CFR 1926 (.62) (i)(4) when using the room.

### 1.17 POSTED WARNINGS AND NOTICES

The following regulations, warnings, and notices shall be posted at the worksite in accordance with 29 CFR 1926 (.62).

#### 1.17.1 Regulations

At least two copies of 29 CFR 1926 (.62) shall be made available for use by either the Contracting Officer or affected workers; and for the purpose of providing required information and training to the workers involved in the project. One copy shall be maintained in the Contractor's jobsite file, and a second copy shall be posted where it will be accessible to workers on the site.

#### 1.17.2 Warning Signs and Labels

Warning signs shall be posted in each lead hazard control area where worker exposure to lead is undetermined or where the exposures are above the permissible exposure limit as defined in 29 CFR 1926 (.62). Signs shall be located to allow personnel to read the signs and take necessary precautions before entering the lead hazard control area.

##### 1.17.2.1 Warning Signs

Warning signs shall be in English and be of sufficient size to be clearly legible, and display the following:

WARNING  
LEAD WORK AREA  
POISON  
NO SMOKING OR EATING

##### 1.17.2.2 Warning Labels

Warning labels shall be affixed to all lead waste disposal containers used to hold materials, debris and other products contaminated with lead hazards; warning labels shall be in English and be of sufficient size to be clearly legible, and display the following:

CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY  
BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN

## ACCORDANCE WITH APPLICABLE FEDERAL, STATE OR LOCAL REGULATIONS.

## 1.17.3 Worker Information

Right-to-know notices shall be placed in clearly visible areas accessible to personnel on the site, to comply with Federal, state, and local regulations.

## 1.17.4 Air Monitoring Results

Air monitoring results shall be prepared so as to be easily understood by the workers. One copy shall be maintained in the Contractor's jobsite file, and a second copy shall be posted where it will be accessible to the workers as specified in 29 CFR 1926 (.62).

## 1.17.5 Emergency Telephone Numbers

A list of emergency telephone numbers shall be posted at the site. The list shall include numbers of the local hospital, emergency squad, police and fire departments, Government and Contractor representatives who can be reached 24 hours per day, and professional consultants directly involved in the project.

## 1.18 MATERIALS AND EQUIPMENT

Sufficient quantities of health and safety materials required by 29 CFR 1926 (.62), and other materials and equipment needed to complete the project, shall be available and kept on the site.

## 1.18.1 Vacuum Systems

Vacuum systems shall be suitably sized for the project, and filters shall be capable of trapping and retaining all mono-disperse particles as small as 0.3 micrometers at a minimum efficiency of 99.97 percent. Used filters that are being replaced shall be disposed in a proper manner.

## 1.18.2 Detergents and Cleaners

Detergents or cleaning agents used shall have demonstrated effectiveness in lead control work using cleaning techniques specified by HUD 6780 guidelines.

## 1.19 EXPENDABLE SUPPLIES

## 1.19.1 Polyethylene Bags

Disposable bags shall be polyethylene plastic and shall be a minimum of 6 mils thick (4 mils thick if double bags are used) or any other thick plastic material shown to demonstrate at least equivalent performance; and shall be capable of being made leak-tight. Leak-tight means that solids, liquids or dust cannot escape or spill out.

## 1.19.2 Polyethylene Leak-tight Wrapping

Wrapping used to wrap lead contaminated debris shall be polyethylene plastic that is a minimum of 6 mils thick or any other thick plastic material shown to demonstrate at least equivalent performance.

## 1.19.3 Polyethylene Sheeting

Sheeting shall be polyethylene plastic with a minimum thickness of 6 mil, or any other thick plastic material shown to demonstrate at least equivalent performance; and shall be provided in the largest sheet size reasonably accommodated by the project to minimize the number of seams. Where the project location constitutes an out of the ordinary potential for fire, or where unusual fire hazards cannot be eliminated, flame-resistant polyethylene sheets which conform to the requirements of NFPA 701 shall be provided.

#### 1.19.4 Tape and Adhesive Spray

Tape and adhesive shall be capable of sealing joints between polyethylene sheets and for attachment of polyethylene sheets to adjacent surfaces. After dry application, tape or adhesive shall retain adhesion when exposed to wet conditions, including amended water. Tape shall be minimum 2 inches wide, industrial strength.

#### 1.19.5 Containers

When used, containers shall be leak-tight and shall be labeled in accordance with EPA, DOT and OSHA standards, as specified in paragraph WARNING LABELS.

### 1.20 STORAGE OF MATERIALS

Materials shall be stored protected from damage and contamination. During periods of cold weather, plastic materials shall be protected from the cold. Flammable or hazardous materials shall not be stored inside a building. Materials shall be regularly inspected to identify damaged or deteriorating items. Damaged or deteriorated items shall not be used and shall be removed from the site as soon as they are discovered. Stored materials shall not present a hazard or an inconvenience to workers, visitors, and/or other occupants and employees of the facility in which they are located.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

### 3.1 WORK PROCEDURES

The Contractor shall perform work following practices and procedures described accident prevention plan.

#### 3.1.1 Lead Hazard Control Areas, Equipment and Procedures

The Contractor shall set up lead hazard control areas and operate equipment within the lead hazard control area in a manner that will minimize migration of lead dust beyond the lead hazard control area boundaries and minimize exposure to workers.

#### 3.1.2 Lead Hazard Control Areas

Access into lead hazard control areas by the general public shall be prohibited. Workers entering the lead hazard control area shall meet medical surveillance requirements of this contract and shall be required to understand and follow procedures described in the Contractor's accident prevention plan for reducing lead exposure.

### 3.2 USE OF HYGIENE FACILITIES

a. Personnel and equipment shall be decontaminated when exiting the lead hazard control area. The Contractor shall comply with the following personnel and equipment decontamination procedures:

- (1) HEPA vacuum outer garments and equipment.
- (2) Wet Wipe Equipment.
- (3) Remove outer layer of garments.
- (4) Thoroughly wash face and hands, if showering not required.
- (5) Shower (if applicable).
- (6) Remove Respirator (if applicable).
- (7) Exit lead hazard control area.

b. The Contractor shall provide, and workers shall use, a change room to change into work clothing at the beginning of a work shift. At the end of the work shift workers shall change back into street clothing and leave contaminated work clothing at the site for disposal or laundering.

c. The Contractor shall provide an eating facility as free as practical from lead contamination. Workers shall be allowed usage of the eating facility for rest/lunch breaks.

### 3.3 FURNISHINGS

The Contractor shall remove furniture and equipment from the buildings and the bunker before lead hazard control work begins.

### 3.4 WASTE DISPOSAL PROCEDURES

#### 3.4.1 Waste Stream Classification

The Contractor shall determine the RCRA waste classification for all waste streams generated by the lead hazard control project. The Contractor shall perform the sampling and analysis, , evaluate analytical results and propose waste stream treatment and disposal requirements for the contract. The Contracting Officer will approve waste stream treatment and disposal requirements proposed by the Contractor.

### 3.5 LEAD HAZARD CONTROL PROCEDURES, METHODS AND TECHNIQUES.

#### 3.5.1 Paint Removal Methods

Prohibited paint removal methods shall include: open flame burning or torching, including the use of heat guns having operating temperatures greater than 1,100 degrees F; machine sanding or grinding without HEPA exhaust; non-contained hydro blasting or high-pressure water wash; abrasive blasting or sandblasting without HEPA exhaust; dry scraping, except near electrical outlets or when using a heat gun. Chemical paint removers containing methylene chloride are prohibited. Stripping shall be done according to manufacturer's recommendations. Stripped substrates shall be thoroughly washed and neutralized before applying a primer or sealing coat.

##### 3.5.1.1 Lead Work

The work area shall be secured to prevent access by children and unauthorized personnel. Workers shall be provided with the appropriate personal protective clothing and equipment in accordance with Lead Hazard Control Plan. Perform lead work in accordance with the Lead Hazard Control Plan and federal, State, and local regulations. Waste disposal shall be in accordance with paragraph WASTE DISPOSAL PROCEDURES.

### 3.6 CLEARANCE PROCEDURES

#### 3.6.1 Visual Inspection

QSHP shall perform a visual inspection, using the form at the end of this section, for each lead hazard control area to assure that lead hazard control activities, identified in the individual work task data elements, have been properly completed. The QSHP shall visually verify that lead hazards have been removed, control technology has been appropriately applied/installed and that the lead hazard control area is free of dust and paint chips generated by lead hazard control activities.

#### 3.6.2 Analytical Demonstration of Clearance

After the visual inspection the QSHP independent risk assessor shall take clearance samples for laboratory analysis to verify clearance requirements specified in paragraph CLEARANCE REQUIREMENTS have been met.

### 3.7 EVALUATION OF SAMPLING AND MONITORING RESULTS

Analytical results from samples taken during lead hazard control activities shall be evaluated to determine compliance with occupational safety and health standards and project specific control efficiency and clearance/clean up levels.

#### 3.7.1 Occupational Safety and Health

The QSHP shall review the analytical results from samples taken for the initial exposure assessment and continued occupational safety and health monitoring if required. Effectiveness and adequacy of personal protective equipment, respirators, work practices, hygiene facilities and personal decontamination procedures shall be evaluated and upgrades/downgrades in equipment and procedures made. After notifying the Contracting Officer the following shall be applied:

- a. Exposures over the PEL (0.05 mg/cubic meter):
  - (1) Improve work practices to reduce exposures.
  - (2) Don respirators.
  - (3) Assure eating facilities and change rooms are clean and are free from settled dust.
  - (4) Shower as part of personal decontamination.
- b. Exposures over the Action Level (0.03 mg/cubic meter):
  - (1) Assure exposed individuals enrolled in the medical surveillance program.
  - (2) Assure exposed individuals enrolled in and up to date with

lead exposure training requirements.

### 3.7.2 Control Efficiency of Containment Features

The QSHP shall review and document results of the visual inspection determining visual clearance criteria are being met while lead hazard control activities are being performed. The QSHP shall review analytical results from samples taken to determine if lead is migrating outside lead hazard control areas at levels in excess of clearance criteria. The QSHP shall notify the Contracting Officer and apply the following actions if results exceed project specific clearance levels outside the lead hazard control area:

- a. Require/improve containment.
- b. Improve work practices to reduce lead aerosol generation.

### 3.7.3 Clearance

The QSHP shall review analytical results for the samples taken to determine compliance with project specific clearance requirements. The following actions apply and shall be performed at the Contractor's expense if project specific clearance levels are exceeded:

- Reclean surfaces.
- Retest to determine clearance.

### 3.7.4 Removal of Lead Hazard Control Area

Upon acceptance of the final clearance certification by the Contracting Officer, and when authorized, cleared Lead Hazard Control Area boundary controls and warning signs shall be removed.

## 3.8 CLEARANCE REPORT

The QSHP shall prepare a clearance report including the following information:

- a. Start and completion dates of lead hazard control activities.
- b. Type of lead hazard control activity performed (i.e., abatement, interim control, renovation, remodeling), locations and lead hazards controlled or abated.
- c. The name and address of each firm conducting lead hazard control activities and the name of each supervisor assigned to the project.
- d. The Occupant Protection Plan prepared pursuant to paragraph OCCUPANT PROTECTION PLAN.
- e. The name, address and signature of the QSHP or independent risk assessor to indicate clearance requirements have been met.
- f. Certification of each Final Cleaning and Visual Inspection performed by the QSHP.
- g. Analytical results from clearance sampling performed by the QSHP or independent risk assessor, the name of the laboratory that conducted the analysis. Results shall be provided in both the

laboratory report and on the appropriate example forms provided at the end of this section.

- h. A detailed written description of the lead hazard control activities performed, including hazard control methods used, locations of rooms and/or components where lead hazard control activities occurred, reason for selecting particular hazard control methods for each component, and any suggested monitoring of encapsulants or enclosures.
- i. Hazardous waste disposal documentation.
- j. Contractor provided installation/maintenance manuals.

### 3.9 TITLE TO MATERIALS

Materials resulting from demolition work, except as specified otherwise, shall be come the property of the Contractor, and shall be disposed of in accordance with Section 02220A DEMOLITION, except as specified.

### 3.10 PAYMENT FOR HAZARDOUS WASTE

Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Government.

### 3.11 CERTIFICATION OF VISUAL INSPECTION

Certify that the lead hazard control area(s) for each individual work task data elements have passed visual clearance criteria and are ready for clearance sampling. To pass visual clearance, lead hazards have to be removed; control technology appropriately applied/installed; the lead hazard control area must be free from visible dust debris, paint chips or any other residue that may have been generated by the lead hazard control activities.



I certify that the clearance samples taken meet the clearance sampling requirements of this contract.

By: \_\_\_\_\_ Date: \_\_\_\_\_  
QSHP or independent risk assessor

Print name and Title: \_\_\_\_\_

CONTRACTING OFFICER ACCEPTANCE OR REJECTION

I have inspected sampling locations and procedures and have found them to be \_\_\_\_\_ Acceptable, meet contract requirements.

\_\_\_\_\_ Unacceptable, do not meet contract requirements, Contractor is directed to resample.

By: Contracting Officer's Representative

Signature \_\_\_\_\_ Date \_\_\_\_\_  
Print Name and Title \_\_\_\_\_

INDIVIDUAL WORK TASK DATA ELEMENTS

Sheet \_\_\_\_\_ of \_\_\_\_\_

There is a separate data sheet for each individual work task.

WORK TASK DESIGNATION NUMBER: \_\_\_\_\_

- 2. LOCATION OF WORK TASK:
- 3. BRIEF DESCRIPTION OF THE LEAD HAZARD CONTROL ACTIVITY:
- 4. POST LEAD HAZARD CONTROL BUILDING/FACILITY USE: COMMERCIAL/PUBLIC
- 5. LEAD CONTAMINATED DEBRIS DISPOSAL DESTINATION:
- 6. CLEARANCE REQUIREMENTS: 40 CFR 745 24 CFR 35 VISUAL

-- End of Section --

## SECTION 13720

ELECTRONIC SECURITY SYSTEM  
05/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI X3.92 (1981; R 1993) Data Encryption Algorithm  
ANSI X3.154 (1988; R 1994) Office Machines and Supplies  
- Alphanumeric Machines-Keyboard Arrangement

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices  
47 CFR 68 Connection of Terminal Equipment to the  
Telephone Network

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170 (1957) Electrical Performance Standards -  
Monochrome Television Studio Facilities  
EIA ANSI/EIA/TIA-232-F (1997) Interface Between Data Terminal  
Equipment and Data Circuit-Terminating  
Equipment Employing Serial Binary Data  
Interchange  
EIA ANSI/EIA-310-D (1992) Cabinets, Racks, Panels, and  
Associated Equipment  
EIA ANSI/TIA/EIA-568-A (1995; Addendum 3 1998) Commercial Building  
Telecommunications Cabling Standard

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code  
IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits  
IEEE Std 142 (1991) IEEE Recommended Practice for  
Grounding of Industrial and Commercial  
Power Systems

## INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7810 (1995) Identification Cards - Physical

## Characteristics

ISO 7811-1	(1995) Identification Cards - Recording Technique - Part 1: Embossing
ISO 7811-2	(1995) Identification Cards - Recording Technique - Part 2: Magnetic Stripe
ISO 7811-3	(1995) Identification Cards - Recording Technique - Part 3: Location of Embossed Characters on ID-1 Cards
ISO 7811-4	(1995) Identification Cards - Recording Technique - Part 4: Location of Read-Only Magnetic Tracks - Tracks 1 and 2
ISO 7811-5	(1995) Identification Cards - Recording Technique - Part 5: Location of Read-Write Magnetic Track - Track 3

## INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU V.34	(1994) Data Communication Over the Telephone Network A Modem Operating at Data Signaling Rates of up to 28,800 bits for use on the General Switched Telephone Network and on Leased Point-to-Point Two-Wire Telephone Type Circuits
ITU V.42	(1993) Data Communications Over the Telephone Network Error-Correcting Procedures for DCEs Using Asynchronous-to-Synchronous Conversion

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Control and Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
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## UNDERWRITERS LABORATORIES (UL)

UL 294	(1999) Access Control System Units
UL 639	(1997; Rev thru Mar 1999) Intrusion Detection Units
UL 681	(1999) Installation and Classification of Burglar and Holdup Alarm Systems
UL 796	(1999) Printed-Wiring Boards
UL 1037	(1999) Antitheft Alarms and Devices

UL 1076

(1995; Rev thru Feb 1999) Proprietary  
Burglar Alarm Units and Systems

## 1.2 SYSTEM DESCRIPTION

THE CONTRACTOR SHALL PROVIDE ALL CONDUIT, WIRING, CONSOLE, SIGNAL AND DATA TRANSMISSION (DTS) AS INDICATED AND REQUIRED BY THE EQUIPMENT MANUFACTURER (VINDICATOR), TO MAKE READY THE STRUCTURED PATHWAY AND CABLING SYSTEM FOR THE ESS FOR THE GOVERNMENT TO INSTALL THEIR SECURITY COMPONENTS. THE INFORMATION CONTAINED HEREIN THIS SPECIFICATION AND AS INDICATED ON THE DRAWINGS, INDICATES THE CONTRACTORS REQUIREMENTS FOR THE PATHWAY AND CABLING SYSTEM FOR THE ESS AND THE COMPONENT AND PERFORMANCE REQUIREMENTS FOR THE GOVERNMENT. The Electronic Security System shall be comprised of all systems/subsystems, but not limited to, Intrusion Detection System/Subsystem and Entry Control System/Subsystem and all other required Systems/Subsystems to perform the functions described herein. All systems/subsystems shall interface as one Electronic Security System (ESS). The ESS shall be completely compatible with and transmit alarm signals to the base security system (Law Enforcement Desk), and manufactured by Vindicator. Transmission to the base security system shall include, but not be limited to, 16 different distinguishable transmission types(i.e. zones, devices, alarm, trouble signals, etc. Coordinate the exact type of signals required to transmit to the base security system, with the Contracting Officer. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A computing devices and labeled as set forth in 47 CFR 15. Electronic equipment shall comply with 47 CFR 15.

The following Vindicator equipment and components are required for this project. Quantities will be as indicated on the drawings and as required by the manufacturer Vindicator to provide a complete operable and functioning security system (intrusion detection and access control and interface with the multiple closed circuit television systems throughout the building).

- a. Photo ID Badging Station Complete, Vindicator Catalog Model WIN IVS 600-32488-02
- b. Security Archive Workstation Complete, Vindicator Catalog Model SAW
- c. LCD Based Graphic Display - 17 inch color, Vindicator Catalog Model SAW
- d. Premises Control Unit, Vindicator Catalog Model PCU
- e. UHS 6842 Network Communications Network, Vindicator Catalog Model PCU
- f. Dial Up Modem, Vindicator Catalog Model Modem
- g. Card Swipe with PIN Keypad, Vindicator Catalog Model Card Swipe with PIN Keypad
- h. Triple Reed High Security Balanced Magnaetic Switch, Vindicator Catalog Model BMS
- i. Dual Technology Volumetric Detector, Vindicator Catalog Model PIR/US
- j. Magnetic Lock, Vindicator Catalog Model ML

j. Pre Encoded Magnetic Cards,Vindicator Catalog Model Mag Card

1.2.1 Central Station (Security Control Console)

The central station shall be configured to provide operator interface, interaction, dynamic and real time monitoring, display, and control. The central station shall control system networks to interconnect all system components including subordinate or separate control stations, enrollment stations and field equipment. The system shall be able to manage up to 16,000 uniquely identifiable inputs and outputs.

1.2.2 Systems Networks

System networks shall interconnect all components of the system. These networks shall include communications between a central station and any subordinate or separate station, enrollment stations, local annunciation stations, portal control stations or redundant central stations. The systems network shall provide totally automatic communication of status changes, commands, field initiated interrupts and any other communications required for proper system operation. System communication shall not require operator initiation or response. System communication shall return to normal after any partial or total network interruption such as power loss or transient upset. The system shall automatically annunciate communication failures to the operator with identification of the communication link that has experienced a partial or total failure. A communications controller may be used as an interface between the central station display systems and the field device network. The communications controller shall provide those functions needed to attain the specified network communications performance.

1.2.2.1 Console Network

A console network, if required, shall provide communication between a central station and any subordinate or separate stations of the system. Where redundant central or parallel stations are required, the console network shall allow the configuration of stations as master and slave. The console network may be a part of the field device network or may be separate depending upon the manufacturer's system configuration.

1.2.2.2 Field Device Network

The field device network shall provide communication between a central control station and field devices of the system. The field device network shall be configured as shown in the drawings. Field devices shall consist of alarm annunciation local processors and entry control local processors (also indicated as PCU and/or access manager controller) Each field device shall be interrogated during each interrogation cycle. The field device network shall provide line supervision that detects and annunciates communications interruptions or compromised communications between any field device and the central station.

1.2.3 Field Equipment

Field equipment shall include local processors, sensors and controls. Local processors shall serve as an interface between the central station and sensors and controls. Data exchange between the central station and the local processors shall include down-line transmission of commands,

software and databases to local processors. The up line data exchange from the local processor to the central station shall include status data such as intrusion alarms, status reports and entry control records. Local processors are categorized as alarm annunciation or entry control.

#### 1.2.4 CCTV System Interface

An interface shall be provided for connection of the central station to the CCTV system as specified in Section 16751 CLOSED CIRCUIT TELEVISION SYSTEMS and as shown. This shall not be accomplished by using an electro-mechanical relay assembly.

#### 1.2.5 Overall System Reliability Requirements

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours.

#### 1.2.6 Error Detection and Retransmission

A cyclic code error detection method shall be used between local processors and the central station, which shall detect single and double bit errors, burst errors of 8 bits or less, and at least 99 percent of all other multibit and burst error conditions. Interactive or product error detection codes alone will not be acceptable. A message shall be in error if 1 bit is received incorrectly. The system shall retransmit messages with detected errors. A 2-digit decimal number shall be operator assignable to each communication link representing the number of retransmission attempts. When the number of consecutive retransmission attempts equals the assigned quantity, the central station shall print a communication failure alarm message. The system shall monitor the frequency of data transmission failure for display and logging.

#### 1.2.7 System Definitions

##### 1.2.7.1 Intrusion Alarm

An alarm resulting from the detection of a specified target, caused by an attempt to intrude into the protected area, or when entry into an entry controlled area is attempted without successfully using entry control procedures.

##### 1.2.7.2 Nuisance Alarm

An alarm resulting from the detection of an appropriate alarm stimulus, but which does not represent an attempt to intrude into the protected area.

##### 1.2.7.3 Environmental Alarm

An alarm during environmental conditions which exceed those specified.

##### 1.2.7.4 False Alarm

An alarm when there is no alarm stimulus.

##### 1.2.7.5 Duress Alarm

An alarm condition which results from a set of pre-established conditions such as entering a special code into a keypad or by activating a switch.

This alarm category shall take precedence over other alarm categories.

#### 1.2.7.6 Guard Tour Alarm

An alarm resulting from a guard being either early or late at a specified check-in location.

#### 1.2.7.7 Fail-Safe Alarm

An alarm resulting from detection of diminished functional capabilities.

#### 1.2.7.8 Power Loss Alarm

An alarm resulting from a loss of primary power.

#### 1.2.7.9 Entry Control Alarm

An alarm resulting from improper use of entry control procedures or equipment.

#### 1.2.7.10 Identifier

A card credential, keypad personal identification number or code, biometric characteristic or any other unique identification entered as data into the entry control database for the purpose of identifying an individual. Identifiers shall be used by the electronic security system for the purpose of validating passage requests for areas equipped with entry control equipment.

#### 1.2.7.11 Entry Control Devices

Any equipment which gives a user the means to input identifier data into the entry control system for verification.

#### 1.2.7.12 Facility Interface Device

A facility interface device shall be any type of mechanism which is controlled in response to passage requests and allows passage through a portal.

#### 1.2.8 Probability of Detection

Each zone shall have a continuous probability of detection greater than 90 percent and shall be demonstrated with a confidence level of 95 percent. This probability of detection is defined as 49 successful detections out of 50 tests or 96 successful detections out of 100 tests.

#### 1.2.9 Standard Intruder

The system shall be able to detect an intruder that weighs 100 pounds or less and is 5 feet tall or less. The intruder shall be dressed in a long-sleeved shirt, slacks and shoes unless environmental conditions at the site require protective clothing.

##### 1.2.9.1 Standard Intruder Movement

Standard intruder movement is defined as any movement such as walking, running, crawling, rolling, or jumping through a protected zone in the most advantageous manner for the intruder.

### 1.2.10 False Alarm Rate

#### 1.2.10.1 Interior

A false alarm rate of no more than 1 false alarm per sensor per 30 days at the specified probability of detection shall be provided.

#### 1.2.10.2 Exterior

A false alarm rate of no more than 1 false alarm per sensor per 5 days at the specified probability of detection shall be provided.

### 1.2.11 Error and Throughput Rates

Error and throughput rates shall be single portal performance rates obtained when processing individuals 1 at a time.

#### 1.2.11.1 Type I Error Rate

Type I error rate is defined as an error where the system denies entry to an authorized, enrolled individual. The rate shall be less than 1 percent.

#### 1.2.11.2 Type II Error Rate

Type II error rate is defined as an error where the system grants entry to an unauthorized individual. The entry control Type II error rate shall be less than 0.001 percent.

### 1.2.12 System Throughput

At the specified error rates, the system throughput rate through a single portal shall be as shown.

### 1.2.13 Passage

Passage is defined as ingress and/or egress past an entry control device, or through a portal. Entry control procedures and equipment shall be implemented for passage through each portal as shown.

### 1.2.14 Detection Resolution

The system shall have detection resolution sufficient to locate intrusions at each device and zone; and tampering at individual devices.

### 1.2.15 Electrical Requirements

Electrically powered ESS equipment shall operate on 120 volt 60 Hz ac sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

### 1.2.16 Power Line Surge Protection

Equipment connected to alternating current circuits shall be protected from power line surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

### 1.2.17 Sensor and Device Wiring and Communication Circuit Surge Protection

Inputs shall be protected against surges induced on device wiring. Outputs shall be protected against surges induced on control and device wiring installed outdoors and as shown. Communications equipment shall be protected against surges induced on any communications circuit. Cables and conductors, except fiber optics, which serve as communications circuits from console to field equipment, and between field equipment, shall have surge protection circuits installed at each end. Protection shall be furnished at equipment, and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 Volts and a peak current of 60 amperes.
- b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 Volts and a peak current of 500 amperes.

#### 1.2.18 Power Line Conditioners

A power line conditioner shall be furnished for the console equipment and each local processor. The power line conditioners shall be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioners shall be sized for 125 percent of the actual connected kVA load. Characteristics of the power line conditioners shall be as follows:

- a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
- b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.
- c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

#### 1.2.19 System Reaction

##### 1.2.19.1 System Response

The field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the central station within 1 second of the alarm occurring at a local processor or device controlled by a local processor, and within 100 milliseconds if the alarm occurs at the central station. Alarm and status changes shall be displayed within 100 milliseconds after receipt of data by the central station. All graphics shall be displayed, including graphics generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

##### 1.2.19.2 System Heavy Load Definition

For the purpose of system heavy load definition, the system shall consist of central station equipment, communication controller and required local processors. System heavy load conditions are defined as the occurrence of alarms at the rate of 10 alarms per second distributed evenly among all local processors in the system. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second.

#### 1.2.20 Environmental Conditions

##### 1.2.20.1 Interior, Controlled Environment

System components, except the console equipment installed in interior locations, having controlled environments shall be rated for continuous operation under ambient environmental conditions of 36 to 122 degrees F dry bulb and 20 to 90 percent relative humidity, non-condensing.

##### 1.2.20.2 Interior, Uncontrolled Environment

System components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 0 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, non-condensing.

##### 1.2.20.3 Exterior Environment

System components that are installed in locations exposed to weather shall be rated for continuous operation under ambient environmental conditions of minus 30 to 122 degrees F dry bulb and 10 to 95 percent relative humidity, condensing. In addition, the system components shall be rated for continuous operation when exposed to performance conditions as specified in UL 294 and UL 639 for outdoor use equipment. Components shall be rated for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 2 feet thick, measured vertically.

##### 1.2.20.4 Console

Console equipment, unless designated otherwise, shall be rated for continuous operation under ambient environmental conditions of 60 to 85 degrees F and a relative humidity of 20 to 80 percent.

#### 1.2.21 System Capacity

The system shall monitor and control the number of inputs and outputs indicated and shall include an expansion capability of a minimum of 100 percent. The system shall discriminate to the individual sensors, switches, and terminal devices and report status at the central station. Backup power shall be provided to operate the complete system and all devices in detection mode for 24 hours and in alarm mode for 30 minutes.

### 1.3 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

All items of computer software, software license and technical data (including technical data which relates to computer software), which is of the ESS shall be delivered to the Contracting Officer and become the property of the Government, including all warrants and technical support. All data delivered shall be identified by reference to the particular

specification paragraph against which it is furnished.

### 1.3.1 Group I Technical Data Package

#### 1.3.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. Console installation, block diagrams, and wiring diagrams.
- c. Local processor installation, typical block, and wiring diagrams.
- d. Local processor physical layout and schematics.
- e. Device wiring and installation drawings.
- f. Details of connections to power sources, including power supplies and grounding.
- g. Details of surge protection device installation.
- h. Sensor detection patterns.
- i. Details of interconnections with CCTV system.

#### 1.3.1.2 Manufacturer's Data

The data package shall include manufacturer's data for all materials and equipment, including terminal devices, local processors and central station equipment provided under this specification.

#### 1.3.1.3 System Description and Analyses

The data package shall include system descriptions, analyses, and calculations used in sizing equipment specified. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Central processor memory size.
- b. Communication speeds and protocol descriptions.
- c. Hard disk size and configuration.
- d. Floppy disk size and configuration.
- e. Alarm response time calculations.
- f. Command response time calculations.
- g. Start-up operations.
- h. Expansion capability and method of implementation.
- i. Sample copy of each report specified.

- j. Color photographs representative of typical graphics.
- k. System throughput calculation.

#### 1.3.1.4 Software Data

The software data package shall consist of descriptions of the operation and capability of system, and application software as specified.

#### 1.3.1.5 Overall System Reliability Calculations

The overall system reliability calculations data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability in accordance with paragraph, OVERALL SYSTEM RELIABILITY REQUIREMENTS.

#### 1.3.1.6 Certifications

Specified manufacturer's certifications shall be included with the data package certification.

#### 1.3.1.7 Key Control Plan

The Contractor shall provide a key control plan. The key control plan shall include the following:

- a. Procedures that will be used to log and positively control all keys during installation.
- b. A listing of all keys and where they are used.
- c. A listing of all persons allowed access to the keys.

#### 1.3.2 Group II Technical Data Package

The Contractor shall prepare a report of "Current Site Conditions" to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. The Contractor shall provide specification sheets, or written functional requirements to support the findings, and a cost estimate to correct those site changes or conditions. The Contractor shall not correct any deficiency without written permission from the Government.

#### 1.3.3 Group III Technical Data Package

The Contractor shall prepare test procedures and reports for the pre-delivery test.

#### 1.3.4 Group IV Technical Data Package

The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval.

##### 1.3.4.1 Operation and Maintenance Manuals

A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be delivered to the Government prior

to beginning the performance verification test for use during site testing.

#### 1.3.4.2 Training Documentation

Lesson plans and training manuals for the training phases, including type of training to be provided, and a list of reference material, shall be delivered for approval.

#### 1.3.4.3 Data Entry

The Contractor shall enter all data needed to make the system operational. The Contractor shall deliver the data to the Government on data entry forms, utilizing data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify and request from the Government, any additional data needed to provide a complete and operational ESS. The completed forms shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.3.4.4 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install the graphics needed to make the system operational. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and other pertinent information in the Contractor's possession to complete the graphics. The Contractor shall identify and request from the Government, any additional data needed to provide a complete graphics package. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 x 10 inches in size, of each type of graphic to be used for the completed system. The graphics examples shall be delivered to the Government for review and approval at least 30 days prior to the Contractor's scheduled need date.

#### 1.3.5 Group V Technical Data Package

Final copies of the manuals as specified, bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representative for each item of equipment. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include modifications made during installation, checkout, and acceptance. The number of copies of each manual to be delivered shall be as specified on DD FORM 1423.

##### 1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

#### 1.3.5.2 Hardware Manual

A manual describing all equipment furnished including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. System schematics and layout drawings.
- e. Alignment and calibration procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.3.5.3 Software Manual

The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

- a. Definition of terms and functions.
- b. Use of system and applications software.
- c. Procedures for system initialization, start-up and shutdown.
- d. Alarm reports.
- e. Reports generation.
- f. Data base format and data entry requirements.
- g. Directory of all disk files.
- h. Description of all communication protocols, including data formats, command characters, and a sample of each type of data transfer.

#### 1.3.5.4 Operator's Manual

The operator's manual shall fully explain all procedures and instructions for the operation of the system, including:

- a. Computers and peripherals.
- b. System start-up and shutdown procedures.
- c. Use of system, and applications software.
- d. Recovery and restart procedures.
- e. Graphic alarm presentation.
- f. Use of report generator and generation of reports.

- g. Data entry.
- h. Operator commands.
- i. Alarm and system messages and printing formats.
- j. System entry requirements.

#### 1.3.5.5 Maintenance Manual

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.3.5.6 Final System Drawings

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the system to be used for final system drawings. This set shall be accurately kept up-to-date by the Contractor with all changes and additions to the ESS and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Final drawings submitted with the endurance test report shall be finished drawings on vellum and CD-ROM.

### 1.4 TESTING

#### 1.4.1 General

The Contractor shall perform pre-delivery testing, site testing, and adjustment of the completed ESS. The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test; notice shall not be given until after the Contractor has received written approval of the specific test procedures.

#### 1.4.2 Test Procedures and Reports

Test procedures shall explain in detail, step-by-step actions and expected results, demonstrating compliance with the requirements specified. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

### 1.5 TRAINING

#### 1.5.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the system as specified. The training shall be oriented to the specific system being installed. Training manuals shall be delivered for each trainee with 2 additional copies delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor shall furnish audio-visual equipment and other training materials and supplies. Where the Contractor presents portions of the course by audio-visual material, copies of the audio-visual material shall be delivered to the Government either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is defined as 8 hours of classroom

instruction, including 2 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with ESS. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

#### 1.5.2 Operator's Training I

The first course shall be taught at the project site for a period of 5 consecutive training days at least 3 months prior to the scheduled performance verification test. A maximum of 12 personnel shall attend this course. Upon completion of this course, each student, using appropriate documentation, shall be able to perform elementary operations with guidance and describe the general hardware architecture and functionality of the system. This course shall include:

- a. General System hardware architecture.
- b. Functional operation of the system.
- c. Operator commands.
- d. Data base entry.
- e. Reports generation.
- f. Alarm reporting.
- g. Diagnostics.

#### 1.5.3 Operator's Training II

The second course shall be taught at the project site for a period of 5 consecutive training days during or after the Contractor's field testing, but before commencing the performance verification test. A maximum of 12 personnel shall attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall include instruction on the specific hardware configuration of the installed system and specific instructions for operating the installed system. Upon completion of this course, each student shall be able to start the system, operate the system, recover the system after a failure, and describe the specific hardware architecture and operation of the system.

#### 1.5.4 Operator's Training III

The third course shall be taught while the endurance test is in progress for a total of 16 hours of instruction per student, in time blocks of 4 hours. A maximum of 12 personnel shall attend the course. The schedule of instruction shall allow for each student to receive individual instruction for a 4-hour period in the morning (or afternoon) of the same weekday. The Contractor shall schedule his activities during this period so that the specified amount of time will be available during the endurance test for instructing the students. The course shall consist of hands-on training under the constant monitoring of the instructor. The instructor shall be responsible for determining the appropriate password to be issued to the student commensurate with each student's acquired skills at the beginning

of each of these individual training sessions. Upon completion of this course, the students shall be fully proficient in the operation of the system.

#### 1.5.5 System Manager Training

4 system managers shall be trained for at least 3 consecutive days. The system manager training shall consist of the operator's training and the following:

- a. Enrollment/disenrollment.
- b. Assignments of identifier data.
- c. Assign operator password/levels.
- d. Change database configuration.
- e. Modify graphics.
- f. Print special or custom reports.
- g. System backup.
- h. Any other functions necessary to manage the system.

#### 1.5.6 Maintenance Personnel Training

The system maintenance course shall be taught at the project site after completion of the endurance test for a period of 5 training days. A maximum of 5 personnel, designated by the Government, will attend the course. The training shall include:

- a. Physical layout of each piece of hardware.
- b. Troubleshooting and diagnostics procedures.
- c. Repair instructions.
- d. Preventive maintenance procedures and schedules.
- e. Calibration procedures. Upon completion of this course, the students shall be fully proficient in the maintenance of the system.

### 1.6 LINE SUPERVISION

#### 1.6.1 Signal and Data Transmission System (DTS) Line Supervision

All signal and DTS lines shall be supervised by the system. The system shall supervise the signal lines by monitoring the circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment. The system shall initiate an alarm in response to a current change of 5 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTS lines.

#### 1.6.2 Data Encryption

The system shall incorporate data encryption equipment on data transmission

circuits as shown. The algorithm used for encryption shall be the Data Encryption Standard (DES) algorithm described in ANSI X3.92.

#### 1.7 DATA TRANSMISSION SYSTEM

The Contractor shall provide a complete DTS as required and recommended by the manufacturer. Provide the DTS in metal conduit as specified in Section 16415.

#### 1.8 MAINTENANCE AND SERVICE

##### 1.8.1 Warranty Period

The Contractor shall provide services required and equipment necessary to maintain the entire system in an operational state as specified, for a period of 1 year after formal written acceptance of the system, and shall provide necessary material required for performing scheduled adjustments or other nonscheduled work.

##### 1.8.2 Description of Work

The adjustment and repair of the system includes all computer equipment, software updates, communications transmission equipment and DTS, local processors, sensors and entry control, facility interface, and support equipment. Responsibility shall be limited to Contractor installed equipment. The manufacturer's required adjustments and other work as necessary shall be provided.

##### 1.8.3 Personnel

Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any change in personnel.

##### 1.8.4 Schedule of Work

The Contractor shall perform 2 minor inspections at 6 month intervals (or more often if required by the manufacturer), and 2 major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

###### 1.8.4.1 Minor Inspections

Minor inspections shall include visual checks and operational tests of console equipment, peripheral equipment, local processors, sensors, and electrical and mechanical controls. Minor inspections shall also include mechanical adjustments, new ribbons, and other necessary adjustments on printers.

###### 1.8.4.2 Major Inspections

Major inspections shall include work described under paragraph Minor Inspections and the following work:

- a. Clean all system equipment and local processors, including interior and exterior surfaces.
- b. Perform diagnostics on all equipment.

- c. Check, walk test, and calibrate each sensor.
- d. Run all system software diagnostics and correct all diagnosed problems.
- e. Resolve any previous outstanding problems.
- f. Purge and compress data bases.

#### 1.8.4.3 Scheduled Work

Scheduled work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

#### 1.8.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within 2 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.

#### 1.8.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable tests of the performance verification test.

#### 1.8.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.

#### 1.8.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

#### 1.8.9 System Modifications

The Contractor shall make any recommendations for system modification in writing to the Government. System modifications shall not be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operation and maintenance manuals, and other documentation affected.

### 1.8.10 Software

The Contractor shall provide a description of all software updates to the Government, who will then decide whether or not they are appropriate for implementation. After notification by the Government, the Contractor shall implement the designated software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with system operators, and shall be incorporated into the operation and maintenance manuals, and software documentation. There shall be at least 1 scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Contractor's software.

## PART 2 PRODUCTS

### 2.1 MATERIALS REQUIREMENTS

#### 2.1.1 Materials and Equipment

Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's model and serial number in a conspicuous place. System equipment shall conform to UL 294 and UL 1076.

#### 2.1.2 Field Enclosures

##### 2.1.2.1 Interior Sensor

Sensors to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.

##### 2.1.2.2 Exterior Sensor

Sensors to be used in an exterior environment shall be housed in an enclosure that provides protection against windblown dust, rain and splashing water, and hose directed water. Sensors shall be undamaged by the formation of ice on the enclosure.

##### 2.1.2.3 Interior Electronics

System electronics to be used in an interior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 12.

##### 2.1.2.4 Exterior Electronics

System electronics to be used in an exterior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 4X.

#### 2.1.3 Nameplates

Laminated plastic nameplates shall be provided for local processors. Each nameplate shall identify the local processor and its location within the system. Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 x 3 inches, with minimum 1/4 inch high engraved block lettering. Nameplates shall be attached to the inside of the enclosure housing the local processor. Other major

components of the system shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a corrosion resistant plate secured to the item of equipment. Nameplates will not be required for devices smaller than 1 x 3 inches.

#### 2.1.4 Tamper Provisions

##### 2.1.4.1 Tamper Switches

Enclosures, cabinets, housings, boxes, and fittings having hinged doors or removable covers and which contain circuits or connections of the system and its power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. The enclosure and the tamper switch shall function together and shall not allow direct line of sight to any internal components before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door or cover; and shall be wired so that they break the circuit when the door or cover is disturbed.

a. Nonsensor Enclosures: Tamper switches on nonsensor enclosures which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

b. Sensor Enclosures: Tamper switches on sensor enclosures which must be opened to make routine maintenance adjustments to the sensor shall be provided.

##### 2.1.4.2 Enclosure Covers

Covers of pull and junction boxes provided to facilitate initial installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place or by tamper resistant security fasteners. Labels shall be affixed to such boxes indicating they contain no connections.

#### 2.1.5 Locks and Key-Lock Switches

##### 2.1.5.1 Locks

Locks shall be provided on system enclosures for maintenance purposes. Locks shall be UL listed, round-key type with 3 dual, 1 mushroom, 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be arranged so that the key can only be withdrawn when in the locked position. Maintenance locks shall be keyed alike and only 2 keys shall be furnished for all of these locks. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

##### 2.1.5.2 Key-Lock-Operated Switches

Key-lock-operated switches required to be installed on system components

shall be UL listed, round-key type, with 3 dual, 1 mushroom, and 3 plain pin tumblers or conventional key type lock having a combination of 5 cylinder pin and 5-point 3 position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be 2 position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only 2 keys shall be furnished for each key-lock-operated-switch. These keys shall be controlled in accordance with the key control plan as specified in paragraph Key Control Plan.

#### 2.1.5.3 Construction Locks

If the Contractor requires locks during installation and construction, a set of temporary locks shall be used. The final set of locks installed and delivered to the Government shall not include any of the temporary locks.

#### 2.1.6 System Components

System components shall be designed for continuous operation. Electronic components shall be solid state type, mounted on printed circuit boards conforming to UL 796. Printed circuit board connectors shall be plug-in, quick-disconnect type. Power dissipating components shall incorporate safety margins of not less than 25 percent with respect to dissipation ratings, maximum voltages, and current carrying capacity. Control relays and similar switching devices shall be solid state type or sealed electro-mechanical.

##### 2.1.6.1 Modularity

Equipment shall be designed for increase of system capability by installation of modular components. System components shall be designed to facilitate maintenance through replacement of modular subassemblies and parts.

##### 2.1.6.2 Maintainability

Components shall be designed to be maintained using commercially available tools and equipment. Components shall be arranged and assembled so they are accessible to maintenance personnel. There shall be no degradation in tamper protection, structural integrity, EMI/RFI attenuation, or line supervision after maintenance when it is performed in accordance with manufacturer's instructions. The system shall be configured and installed to yield a mean time to repair (MTTR) of not more than 8 hours. Repair time is the clock time from when maintenance personnel gain entrance to the system and begin work, until the system is fully functional.

##### 2.1.6.3 Interchangeability

The system shall be constructed with off-the-shelf components which are physically, electrically and functionally interchangeable with equivalent components as complete items. Replacement of equivalent components shall not require modification of either the new component or of other components with which the replacement items are used. Custom designed or one-of-a-kind items shall not be used. Interchangeable components or modules shall not require trial and error matching in order to meet integrated system requirements, system accuracy, or restore complete system functionality.

##### 2.1.6.4 Product Safety

System components shall conform to applicable rules and requirements of NFPA 70 and UL 294. System components shall be equipped with instruction plates including warnings and cautions describing physical safety, and special or important procedures to be followed in operating and servicing system equipment.

#### 2.1.7 Controls and Designations

Controls and designations shall be as specified in NEMA ICS 1.

#### 2.1.8 Special Test Equipment

The Contractor shall provide all special test equipment, special hardware, software, tools, and programming or initialization equipment needed to start or maintain any part of the system and its components. Special test equipment is defined as any test equipment not normally used in an electronics maintenance facility.

#### 2.1.9 Alarm Output

The alarm output of each sensor shall be a single pole double throw (SPDT) contact rated for a minimum of 0.25 A at 24 Volts dc.

### 2.2 CENTRAL STATION (Security Control Console) HARDWARE

The central station (Security Control Console) computer shall be a standard unmodified digital computer of modular design. The CPU word size shall be 64 bits or larger. The operating speed of the processor shall be at least 150 MHZ.

#### 2.2.1 Memory

The computer shall contain at least 256 megabytes of usable installed memory minimum, expandable to a minimum of 256 megabytes without additional chassis or power supplies.

#### 2.2.2 Power Supply

The power supply shall have a minimum capacity of 250 Watts.

#### 2.2.3 Real Time Clock (RTC)

A RTC shall be provided. Accuracy shall be within plus or minus 1 minute per month. The RTC shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month and shall be resettable by software. The clock shall continue to function for a period of 1 year without power.

#### 2.2.4 Serial Ports

a. Two EIA ANSI/EIA/TIA-232-F serial ports shall be provided for general use.

b. Adjustable data transmission rates from 9600 to 57.6 Kbps shall be selectable under program control.

c. Sixteen additional EIA ANSI/EIA/TIA-232-F serial ports shall be provided as part of a communications coprocessor. The coprocessor word size shall be 32 bytes or larger and the operating speed of the coprocessor

shall be at least 66 MHZ. Communications with the field equipment shall be managed by this device. Multiplexed serial ports shall be expandable to 48 ports with 8 character transmit and receive buffers to each port. Total buffer size shall be a minimum of 1 megabyte.

#### 2.2.5 Parallel Port

An enhanced parallel port shall be provided.

#### 2.2.6 Color Monitor

The monitor shall be no less than 17 inches, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 millimeters. The video card shall support at least 256 colors at a resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

#### 2.2.7 Keyboard A101

A keyboard having a minimum 64 character, standard ASCII character, based on ANSI X3.154 shall be furnished.

#### 2.2.8 Enhancement Hardware

Enhancement hardware such as special function keyboards, special function keys, touch screen devices, or mouse shall be provided for frequently used operator commands such as: Help, Alarm Acknowledge, Place Zone In Access, Place Zone In Secure, System Test, Print Reports, Change Operator, Security Lighting Controls, and Display Graphics.

#### 2.2.9 Disk Storage

A hard disk with controller having a maximum average access time of 10 milliseconds shall be provided. The hard disk shall provide a minimum of 2.0 gigabytes of formatted storage. Additionally, a PCMCIA slot with a removable 500 megabyte hard drive shall be provided.

#### 2.2.10 Floppy Disk Drives

A high density floppy disk drive and controller in 3-1/2 inch size shall be provided.

#### 2.2.11 Magnetic Tape System

A 4 mm cartridge magnetic tape system shall be provided. The system capacity shall be 8.0 gigabytes minimum per tape. Each tape shall be computer grade, in a rigid cartridge with spring-loaded cover and write-protect.

#### 2.2.12 Modem

A modem shall be provided and operate at 56,000 bps, full duplex on circuits using asynchronous communications. Modem shall have error detection, auto answer/autodial, and call-in-progress detection. The modem shall meet the requirements of ITU V.34, ITU V.42 for error correction and ITU V.42 for data compression standards, and shall be suitable for operating on unconditioned voice grade telephone lines in conformance with 47 CFR 68.

#### 2.2.13 Audible Alarm

The manufacturer's standard audible alarm shall be provided.

#### 2.2.14 Mouse

A mouse with a minimum resolution of 400 dots per inch shall be provided.

#### 2.2.15 CD-ROM Drive

A CD-ROM drive having a nominal storage capacity of 650 megabytes shall be provided. The CD-ROM drive shall have the following minimum characteristics:

- a. Data Transfer Rate: 1.2 Mbps.
- b. Average Access Time: 150 milliseconds.
- c. Cache memory: 256 Kbytes.
- d. Data throughput: 1 Mbyte/second, minimum.

#### 2.2.16 Dot Matrix Alarm Printer

A dot matrix alarm printer shall be provided and interconnected to the central station equipment. The dot matrix alarm printer shall have a minimum 96 character, standard ASCII character set, based on ANSI X3.154 and with graphics capability. The printer shall be able to print in both red and black without ribbon change. The printers shall have adjustable sprockets for paper width up to 11 inches, print at least 80 columns per line and have a minimum speed of 200 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per inch. The printers shall utilize sprocket-fed fan fold paper. The units shall have programmable control of top-of-form. Twenty-five thousand sheets of printer paper and 12 ribbons shall be provided after successful completion of the endurance test.

#### 2.2.17 Report Printer

A report printer shall be provided and interconnected to the central station equipment. The printer shall be a laser printer with printer resolution of at least 600 dots per inch. The printer shall have at least 2 megabytes of RAM. Printing speed shall be at least 8 pages per minute with a 100 sheet paper cassette and with automatic feed. Two thousand sheets of paper and 5 toner cartridges shall be furnished after successful completion of the endurance test.

#### 2.2.18 Controllers

Controllers required for operation of specified peripherals, serial, and parallel ports shall be provided.

#### 2.2.19 Central Station Equipment Enclosures

The Contractor shall provide color coordinated consoles and equipment cabinets. Equipment cabinets shall have front and back plexiglass doors, thermostatic controlled bottom-mounted fan, and metal fitted and louvered tops. One locking cabinet approximately 6 feet high, 3 feet wide, 18 to 36 inches deep with 3 adjustable shelves, and 4 storage racks for storage of disks, tapes, printouts, printer paper, ribbons, manuals, and other

documentation shall be provided.

#### 2.2.20 Uninterruptible Power Supply (UPS)

A self contained UPS, suitable for installation and operation at the central station, shall be provided. The UPS shall be sized to provide a minimum of 6 hours of operation of the central station equipment. Equipment connected to the UPS shall not be affected by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power. The UPS shall be as specified in Section 16265, UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 kVa CAPACITY. The UPS condition shall be monitored by the ESS and displayed at the Central Station.

#### 2.2.21 Fixed Map Display

A fixed map display shall be provided showing a layout of the protected facilities. Zones corresponding to those monitored by the system shall be highlighted on the display. Status of each zone shall be displayed using LED's as required within each designated zone. An LED test switch shall be provided on the map display.

#### 2.2.22 Enrollment Center Equipment

Enrollment stations shall be provided and located as shown to enroll personnel into, and disenroll personnel from the system database. The enrollment equipment shall only be accessible to authorized entry control enrollment personnel. The Contractor shall provide enough credential cards for 1500 personnel to be enrolled at the site plus an extra 50 percent for future use. The enrollment equipment shall include subsystem configuration controls and electronic diagnostic aids for subsystem setup and troubleshooting with the central station. A printer shall be provided for the enrollment station which meets the requirements of paragraph Report Printer.

#### 2.2.23 Enrollment Center Accessories

A steel desk-type console, a swivel chair on casters and equipment racks shall be provided. The console shall be as specified in EIA ANSI/EIA-310-D and as shown. Equipment racks shall be as specified in EIA ANSI/EIA-310-D and as shown. All equipment, with the exception of the printers, shall be rack mounted in the console and equipment racks or as shown. The console and equipment racks and cabinets shall be color coordinated. A locking cabinet approximately 6 feet high, 3 feet wide, and 2 feet deep with 3 adjustable shelves, and 2 storage racks for storage of disks, tapes, printouts, printer paper, ribbons, manuals, and other documentation shall be provided.

#### 2.2.24 Secondary Alarm Annunciation Site

Secondary alarm annunciation console shall be located at the buildings main security entry control point room. Hardware and software needed for the secondary alarm annunciation console shall be provided. The secondary alarm annunciation console shall display alarms or system status changes only.

### 2.3 CENTRAL STATION SOFTWARE

Software shall support all specified functions. The central station shall be online at all times and shall perform required functions as specified. Software shall be resident at the central station and/or the local processor as required to perform specified functions.

#### 2.3.1 System Software

System software shall perform the following functions:

- a. Support multiuser operation with multiple tasks for each user.
- b. Support operation and management of peripheral devices.
- c. Provide file management functions for disk I/O, including creation and deletion of files, copying files, a directory of all files including size and location of each sequential and random ordered record.
- d. Provide printer spooling.

#### 2.3.2 Real Time Clock Synchronization

The system shall synchronize each real time clock within 1 second and at least once per day automatically, without operator intervention and without requiring system shutdown.

#### 2.3.3 Database Definition Process

Software shall be provided to define and modify each point in the database using operator commands. The definition shall include all parameters and constraints associated with each sensor, commandable output, zone, facility interface device, terminal device, etc. Each database item shall be callable for display or printing, including EPROM, ROM and RAM resident data. The database shall be defined and entered into the ESS by the Contractor based upon input from the Government.

#### 2.3.4 Software Tamper

The ESS shall annunciate a tamper alarm when unauthorized changes to the system database files are attempted. Three consecutive unsuccessful attempts to log onto the system shall generate a software tamper alarm. A software tamper alarm shall also be generated when an operator or other individual makes 3 consecutive unsuccessful attempts to invoke central processor functions beyond their authorization level. The ESS shall maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. The system shall not allow write access to the system transcript files by any person, regardless of their authorization level. The system shall only allow acknowledgment of software tamper alarms and read access to the system transcript files by operators and managers with the highest password authorization level available in the system.

#### 2.3.5 Application Software

The application software shall provide the interface between the alarm annunciation and entry control local processors; monitor all sensors and DTS links; operate displays; report alarms; generate reports; and assist in training system operators.

#### 2.3.5.1 Operator Commands

The operator's commands shall provide the means for entry of monitoring and control commands, and for retrieval of system information. Processing of operator commands shall commence within 1 second of entry, with some form of acknowledgment provided at that time. The operator's commands shall perform tasks including:

- a. Request help with the system operation.
- b. Acknowledge alarms.
- c. Place zone in access.
- d. Place zone in secure.
- e. Test the system.
- f. Generate and format reports.
- g. Print reports.
- h. Change operator.
- j. Request any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
- k. Entry control functions.

#### 2.3.5.2 Command Input

Operator's commands shall be full English language words and acronyms selected to allow operators to use the system without extensive training or data processing backgrounds. The system shall prompt the operator in English word, phrase, or acronym. Commands shall be available in an abbreviated mode, in addition to the full English language (words and acronyms) commands, allowing an experienced operator to disregard portions, or all, of the prompt-response requirements.

#### 2.3.5.3 Command Input Errors

The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator, in English words and phrases, why the command cannot be executed. Error responses requiring an operator to look up a code in a manual or other document will not be accepted. Conditions for which operator error assist messages shall be generated include:

- a. The command used is incorrect or incomplete.
- b. The operator is restricted from using that command.
- c. The command addresses a point which is disabled or out of service.
- d. The command addresses a point which does not exist.
- e. The command would violate constraints.

#### 2.3.5.4 Enhancements

The system shall implement the following enhancements by use of special function keys, touch screen, or mouse, in addition to all other command inputs specified:

a. Help: Used to produce a display for all commands available to the operator. The help command, followed by a specific command shall produce a short explanation of the purpose, use, and system reaction to that command.

b. Acknowledge Alarms: Used to acknowledge that the alarm message has been observed by the operator.

c. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. The system shall be structured so that tamper circuits cannot be disabled by the console operator.

d. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.

e. System Test: Allows the operator to initiate a system wide operational test.

f. Zone Test: Allows the operator to initiate an operational test for a specific zone.

g. Print Reports: Allows the operator to initiate printing of reports.

h. Change Operator: Used for changing operators.

j. Display Graphics: Used to display any graphic displays implemented in the system.

#### 2.3.5.5 System Access Control

The system shall provide a means to define system operator capability and functions through multiple, password protected operator levels. At least 3 operator levels shall be provided. System operators and managers with appropriate password clearances shall be able to change operator levels for all operators. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm. A minimum of 32 passwords shall be usable with the system software. The system shall display the operator's name or initials in the console's first field. The system shall print the operator's name or initials, action, date, and time on the system printer at log-on and log-off. The password shall not be displayed or printed. Each password shall be definable and assignable for the following:

- a. Commands usable.
- b. Access to system software.
- c. Access to application software.
- d. Individual zones which are to be accessed.
- e. Access to database.

#### 2.3.5.6 Alarm Monitoring Software

This program shall monitor all sensors, local processors and DTS circuits and notify the operator of an alarm condition. Alarms shall be printed in red on the alarm printer and displayed on the console's text and graphics map monitors. Higher priority alarms shall be displayed first; and within alarm priorities, the oldest unacknowledged alarm shall be displayed first.

Operator acknowledgment of one alarm shall not be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms. Alarm data to be displayed shall include type of alarm, location of alarm, and secondary alarm messages. Alarm data to be printed shall include: type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator response. A unique message field with a width of 60 characters shall be provided for each alarm. Assignment of messages to a zone or sensor shall be an operator editable function. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator. The system shall provide for 25 secondary messages with a field of 4 lines of 60 characters each. The most recent 1000 alarms shall be stored and shall be recallable by the operator using the report generator.

#### 2.3.5.7 Monitor Display Software

Monitor display software shall provide for text and graphics map displays that include zone status integrated into the display. Different colors shall be used for the various components and real time data. Colors shall be uniform on all displays. The following color coding shall be followed.

- a. FLASHING RED to alert an operator that a zone has gone into an alarm or that primary power has failed.
- b. RED to alert an operator that a zone is in alarm and that the alarm has been acknowledged.
- c. YELLOW to advise an operator that a zone is in access.
- d. GREEN to indicate that a zone is secure or that power is on.

#### 2.3.5.8 Map Displays/Graphics Linked to Alarms

The System shall relate map displays or other graphics to alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the map display or graphic related to the alarm shall be automatically displayed. The definition of which maps or graphics shall be displayed with each alarm shall be selectable by system operators through simple menu choices as part of the system initial configuration.

#### 2.3.5.9 User Defined Prompts/Messages Linked to Alarms

The System shall provide a means to relate operator defined prompts and other messages to predefined alarms. Whenever one of the predefined alarms is annunciated on a system control terminal, the prompts or messages related to the alarm shall be automatically displayed.

#### 2.3.5.10 System Test Software

This software shall enable the operator to initiate a test of the system. This test can be of the entire system or of a particular portion of the

system at the operator's option. The results of each test shall be stored for future display or print out in report form.

#### 2.3.5.11 Report Generator

Software shall be provided with commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time and shall be printed on the report printer. Reports shall be spooled, allowing the printing of one report to be complete before the printing of another report commences. The dynamic operation of the system shall not be interrupted to generate a report. The report generation mode, either periodic, automatic or on request, shall be operator selectable. The report shall contain the time and date when the report was printed, and the name of operator generating the report. The exact format of each report type shall be operator configurable.

a. Periodic Automatic Report Modes: The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

b. Request Report Mode: The system shall allow the operator to request at any time an immediate printout of any report.

c. Alarm Report: The alarm report shall include all alarms recorded by the system over an operator selectable time. The report shall include such information as: the type of alarm (intrusion, tamper, etc.); the type of sensor; the location; the time; and the action taken.

d. System Test Report: This report documents the operational status of all system components following a system test.

e. Access/Secure Report: This report documents all zones placed in access, the time placed in access, and the time placed in secure mode.

f. Entry Control Reports: The system shall generate hard copy reports of identifier, terminal, and guard tour tracking reports, and versions with defined parameters of the manufacturer's standard management and activity reports.

#### 2.3.5.12 Simulation (Training) Software

This program shall enable operators to practice system operation including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. The system shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.

#### 2.3.5.13 Entry Control Enrollment Software

The enrollment station shall provide database management functions for the system, and shall allow an operator to change and modify the data entered in the system as needed. The enrollment station shall not have any alarm response or acknowledgment functions. Multiple, password protected access levels shall be provided at the enrollment station. Database management and modification functions shall require a higher operator access level than personnel enrollment functions. The program shall provide a means for disabling the enrollment station when it is unattended to prevent unauthorized use. The program shall provide a method to enter personnel

identifying information into the entry control database files through enrollment stations. In the case of personnel identity verification subsystems, this data shall include biometric data. The program shall allow entry of this data into the system database files through the use of simple menu selections and data fields. The data field names shall be customized to suit user and site needs. All personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry control database files.

## 2.4 FIELD PROCESSING HARDWARE

### 2.4.1 Alarm Annunciation Local Processor

The alarm annunciation local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station and change outputs based on commands received from the central station. The local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.

a. Inputs. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions. The local processor shall have at least 8 alarm inputs which allow wiring as normally open or normally closed contacts for alarm conditions. It shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements. The local processor shall report line supervision alarms to the central station. Alarms shall be reported for any condition that remains off normal at an input for longer than 500 milliseconds. Each alarm condition shall be transmitted to the central computer during the next interrogation cycle.

b. Outputs. Local processor outputs shall reflect the state of commands issued by the central station. The outputs shall be a form C contact and shall include normally open and normally closed contacts. The local processor shall have at least 4 command outputs.

#### 2.4.1.1 Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 6 hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored. There will be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa. Batteries shall be sealed, non-outgassing type. The power supply shall be equipped with an indicator for ac input power and an indicator for dc output power. Loss of primary power shall be reported to the central station as an alarm.

#### 2.4.1.2 Auxiliary Equipment Power

A GFI service outlet shall be furnished inside the local processor's enclosure.

### 2.4.2 Entry Control Local Processor

The entry control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station and change outputs based on commands received from the central station. The local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs. The entry control local processor shall provide local entry control functions including communicating with field devices such as card readers, keypads, biometric personal identity verification devices, door strikes, magnetic latches, gate and door operators and exit pushbuttons. The processor shall also accept data from entry control field devices as well as database downloads and updates from the central station that include enrollment and privilege information. The processor shall also send indications of success or failure of attempts to use entry control field devices and make comparisons of presented information with stored identification information. The processor shall grant or deny entry by sending control signals to portal control devices and mask intrusion alarm annunciation from sensors stimulated by authorized entries. The entry control local processor shall use inputs from entry control devices to change modes between access and secure. The local processor shall maintain a date-time and location stamped record of each transaction and transmit transaction records to the central station. The processor shall operate as a stand-alone portal controller using the downloaded data base during periods of communication loss between the local processor and the field device network. The processor shall store up to 1000 transactions during periods of communication loss between the local processor and the field device network for subsequent upload to the central station upon restoration of communication. The local processor shall provide power for field devices and portal control devices.

a. Inputs. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions. The local processor shall have at least 8 alarm inputs which allow wiring as normally open or normally closed contacts for alarm conditions. It shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements. The local processor shall report line supervision alarms to the central station. Alarms shall be reported for any condition that remains off normal at an input for longer than 500 milliseconds. Each alarm condition shall be transmitted to the central station during the next interrogation cycle. The entry control local processor shall include the necessary software drivers to communicate with entry control field devices. Information generated by the entry control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges. Privileges shall include, but not be limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time and location stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

b. Outputs. Local processor outputs shall reflect the state of commands issued by the central station. The outputs shall be a form C contact and shall include normally open and normally closed contacts. The local processor shall have at least 4 commandable outputs. The entry

control local processor shall also provide control outputs to portal control devices.

c. Degraded Mode of Operation. The entry control local processor shall provide a degraded mode of operation for periods when communication between the local processor and the field device network is lost. While in this degraded mode, the local processor shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal control devices. Transactions shall be stored for subsequent transmission to the central station when communication is restored.

#### 2.4.2.1 Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 6 hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa. Batteries shall be sealed, non-outgassing type. The power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.

#### 2.4.2.2 Auxiliary Equipment Power

A GFI service outlet shall be furnished inside the local processor's enclosure.

### 2.5 FIELD PROCESSING SOFTWARE

All Field processing software described in this specification shall be furnished as part of the complete system.

#### 2.5.1 Operating System

Each local processor shall contain an operating system that controls and schedules that local processor's activities in real time. The local processor shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that local processor. The execution of local processor application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each local processor real time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds. The time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown.

##### 2.5.1.1 Startup

The local processor shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected Input/Output functions. A local processor restart program based on detection of power failure at the local processor shall be included in the local processor software. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in

the failure mode indicated until the necessary repairs are made. If the database and application programs are resident, the local processor shall immediately resume operation.

#### 2.5.1.2 Operating Mode

Each local processor shall control and monitor inputs and outputs as specified, independent of communications with the central station. Alarms, status changes and other data shall be transmitted to the central station when communications circuits are operable. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station shall be stored for later transmission to the central station. Storage for the latest 1024 events shall be provided at each local processor. Each local processor shall accept software downloaded from the central station.

#### 2.5.1.3 Failure Mode

Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

#### 2.5.2 Functions

The Contractor shall provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each local processor.

- a. Monitoring of inputs.
- b. Control of outputs.
- c. Reporting of alarms automatically to the central station.
- d. Reporting of sensor and output status to central station upon request.
- e. Maintenance of real time, automatically updated by the central station at least once a day.
- f. Communication with the central station.
- g. Execution of local processor resident programs.
- h. Diagnostics.
- i. Download and upload data to and from the central station.

#### 2.6 INTERIOR SENSORS AND CONTROL DEVICES

##### 2.6.1 Balanced Magnetic Switch (BMS)

The BMS shall detect a 1/4 inch of separating relative movement between the magnet and the switch housing. Upon detecting such movement, the BMS shall transmit an alarm signal to the alarm annunciation system.

##### 2.6.1.1 BMS Subassemblies

The BMS shall consist of a switch assembly and an actuating magnet assembly. The switch mechanism shall be of the balanced magnetic type. Each switch shall be provided with an overcurrent protective device, rated to limit current to 80 percent of the switch capacity. Switches shall be rated for a minimum lifetime of 1,000,000 operations. The magnet assembly shall house the actuating magnet.

#### 2.6.1.2 Housing

The housings of surface mounted switches and magnets shall be made of nonferrous metal and shall be weatherproof. The housings of recess mounted switches and magnets shall be made of nonferrous metal or plastic.

#### 2.6.1.3 Remote Test

A remote test capability shall be provided. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall activate the sensor's switch mechanism causing an alarm signal to be transmitted to the alarm annunciation system. The remote test shall simulate the movement of the actuating magnet relative to the switch subassembly.

#### 2.6.2 Glass Break Sensor, Piezoelectric

The glass break sensor shall detect high frequency vibrations generated by the breaking of glass while ignoring all other mechanical vibrations. An alarm signal shall be transmitted to the alarm annunciation system upon detecting such frequencies.

##### 2.6.2.1 Sensor Element, Piezoelectric

The sensor element shall consist of piezoelectric crystals. The sensor element housing shall be designed to be mounted directly to the glass surface being protected. Only the adhesive recommended by the manufacturer of the sensor shall be used to mount detectors to glass. The detection pattern of a sensor element shall be circular with at least a 5 foot radius on a continuous pane of glass. A factory installed hookup cable of not less than 6 feet shall be included with each sensor. The sensor element shall not exceed 4 square inches. The sensor element shall be equipped with a light emitting diode (LED) activation indicator. The activation indicator shall light when the sensor responds to the high frequencies associated with breaking glass. The LED shall be held on until it is turned off manually at the sensor signal processor or by command from the alarm annunciation system.

##### 2.6.2.2 Sensor Signal Processor, Piezoelectric

The sensor signal processor shall process the signals from the sensor element and provide the alarm signal to the alarm annunciation system. The sensitivity of the sensor shall be adjustable by controls within the sensor signal processor. The controls shall not be accessible when the sensor signal processor housing is in place. The sensor signal processor may be integral with the sensor or may be a separate assembly.

##### 2.6.2.3 Glass Break Simulator, Piezoelectric

The Contractor shall provide a device that can induce frequencies into the protected pane of glass that will simulate breaking glass to the sensor

element without causing damage to the pane of glass.

### 2.6.3 Glass Break Sensor, Acoustic

The glass break sensor shall detect high frequency vibrations generated by the breaking of glass while ignoring all other mechanical vibrations. An alarm signal shall be transmitted upon detecting such frequencies to the alarm annunciation system.

#### 2.6.3.1 Sensor Element, Acoustic

The sensor element shall be a microprocessor based digital device. The sensor shall detect breakage of plate, laminated, tempered, and wired glass while rejecting common causes of nuisance alarms. The detection pattern of the sensor element shall be a range of 20 feet minimum. The sensor element shall be equipped with a light emitting diode (LED) activation indicator. The activation indicator shall light when the sensor responds to the high frequencies associated with breaking glass. The LED shall be held on until it is turned off manually at the sensor signal processor or by command from the alarm annunciation system.

#### 2.6.3.2 Sensor Signal Processor, Acoustic

The sensor signal processor shall process the signals from the sensor element and provide the alarm signal to the alarm annunciation system. The sensitivity of the sensor shall be adjustable by controls within the sensor signal processor. The controls shall not be accessible when the sensor signal processor housing is in place. The sensor signal processor may be integral with the sensor or may be a separate assembly.

#### 2.6.3.3 Glass Break Simulator, Acoustic

The contractor shall provide a device that can simulate breaking glass to the sensor. The device shall be rated for use with the specific sensor selected. The simulator shall not cause damage to the pane of glass.

### 2.6.4 Duress Alarm Switches

Duress alarm switches shall provide the means for an individual to covertly notify the alarm annunciation system that a duress situation exists. Provide a duress alarm at the main entrance security entry control point room.

#### 2.6.4.1 Footrail

Footrail duress alarms shall be designed to be foot activated and floor mounted. No visible or audible alarm or noise shall emanate from the switch when activated. The switch housing shall shroud the activating lever to prevent accidental activation. Switches shall be rated for a minimum lifetime of 50,000 operations.

#### 2.6.4.2 Push-button

Latching push-button duress alarm switches shall be designed to be activated by depressing a push-button located on the duress switch housing. No visible or audible alarm or noise shall emanate from the switch. The switch housing shall shroud the activating button to prevent accidental activation. Switches shall be rated for a minimum lifetime of 50,000 operations.

### 2.6.5 Microwave-Passive Infrared Dual Detection Motion Sensor

The dual detection motion sensor shall be a single unit combining a detector which detects changes in a microwave signal and a detector which detects changes in the ambient level of infrared emissions caused by the movement of a standard intruder within the detection pattern. The detection pattern shall be capable of covering a 20 x 30 foot room. Upon intruder detection by either detector, a time window of more than 3 seconds but less than 8 seconds shall be opened. If the other detector detects an intruder during this window, the sensor shall transmit an alarm signal to the alarm annunciation system. The passive infrared detector shall detect a change in temperature of no more than 2 degrees F, and shall detect a standard intruder traveling within the detection pattern at a speed of 0.3 to 7.5 feet per second across 2 adjacent segments of the field of view. Emissions monitored by the sensor shall be in the range of 8 to 14 microns.

The microwave detector shall detect a standard intruder moving within the detection pattern at a speed of 0.3 to 7.5 feet per second. The microwave detector shall comply with 47 CFR 15, Subpart F. Controls shall not be accessible when the sensor housing is in place. The sensor shall be configured to produce an alarm when both detectors sense an intruder.

#### 2.6.5.1 Test Indicator

The sensor shall be equipped with an LED walk test indicator for both the passive infrared detector and the microwave detector. The walk test indicators shall not be visible during normal operations. When visible, the walk test indicators shall light when the sensor detects an intruder. The sensor shall either be equipped with a manual control, located within the sensor's housing, to enable/disable the test indicators or the test indicators shall be located within the sensor housing so that they can only be seen when the housing is open or removed.

#### 2.6.5.2 Remote Test

A remote test capability shall be provided. The remote test hardware may be integral to the sensor or a separate piece of equipment. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall excite each sensing element and associated electronics causing an alarm signal to be transmitted to the alarm annunciation system. The sensor stimulation generated by the remote test hardware shall simulate a standard intruder moving within the sensor's detection pattern.

### 2.6.6 Capacitance Proximity Sensor

The capacitance sensor shall detect the change in capacitance of at least 20 picofarads between an insulated asset and ground. The sensor shall detect a standard intruder approaching or touching the protected asset. Upon detecting such a change, the sensor shall transmit an alarm signal to the alarm annunciation system. The sensor shall be able to protect multiple assets. The sensitivity of the sensor shall be adjustable by controls within the sensor. The controls shall not be accessible when the sensor housing is in place. Insulator blocks shall be provided for each asset to be protected by the sensor.

#### 2.6.6.1 Test Indicator, Capacitance

The sensor shall be equipped with an LED walk test indicator. The walk

test indicator shall not be visible during normal operations. When visible, the walk test indicator shall light when the sensor detects an intruder. The sensor shall either be equipped with a manual control, located within the sensor's housing, to enable/disable the test indicator or the test indicator shall be located within the sensor housing so that it can only be seen when the housing is open or removed.

#### 2.6.6.2 Remote Test, Capacitance

A remote test capability shall be provided. The remote test hardware may be integral to the sensor or a separate piece of equipment. The remote test shall be initiated when commanded by the alarm annunciation system. The remote test shall excite the sensing element and associated electronics causing an alarm signal to be transmitted to the alarm annunciation system. The sensor stimulation generated by the remote test hardware shall simulate a standard intruder moving within the sensor's detection pattern.

#### 2.6.7 Video Motion Sensor (Interior)

The video motion sensor shall detect changes in the video signal within a user defined detection zone. The system shall detect changes in the video signal corresponding to a standard intruder moving within the defined detection zone and wearing clothing with a reflectivity that differs from that of the background scene by a factor of 2. All other changes in the video signal shall be rejected by the sensor. Upon detecting such changes, the sensor shall transmit an alarm signal to the alarm annunciation system.

The sensor shall include the controls and method needed by the operator to define and adjust the sensor detection zone within the video picture. The number of detection zones, the size of the detection zones, and the sensitivity of the detection zones shall be user definable. The sensor shall be a modular system that allows for expansion or modification of the number of inputs. The video inputs shall accept composite video as defined in EIA 170. Sensor controls shall be mounted on the front panel or in an adjacent rack panel. The sensor shall not require external sync for operation. One alarm output shall be provided for each video input. The number of video inputs and alarm outputs shall be as shown. All components, cables, power supplies, and other items needed for a complete video motion sensor shall be provided. Sensor equipment shall be rack mounted in a standard 19 inch rack as described in EIA ANSI/EIA-310-D. The rack shall include hardware required to mount the sensor components.

#### 2.6.8 Access/Secure Switches

An access/secure switch shall be used to place a protected zone in the ACCESS or SECURE mode. The switch shall consist of a double pull key-operated switch housed in a NEMA 12 equivalent enclosure. The switch shall disable zone sensor alarm outputs, but shall not disable tamper alarms, duress alarms, and other 24 hr sensors, as shown.

### 2.7 EXTERIOR INTRUSION SENSORS

#### 2.7.1 Video Motion Sensor (Exterior)

The video motion sensor shall detect changes in the video signal within a user defined detection zone. The system shall detect changes in the video signal corresponding to a standard intruder moving within the defined detection zone and wearing clothing with a reflectivity that differs from that of the background scene by a factor of 2. All other changes in the video signal shall be rejected by the sensor. Upon detecting such changes,

the sensor shall transmit an alarm signal to the alarm annunciation system.

The sensor shall include the controls and method needed by the operator to define and adjust the sensor detection zone within the video picture. The number of detection zones, the size of the detection zones, and the sensitivity of the detection zones shall be user definable. The sensor shall be a modular system that allows for expansion or modification of the number of inputs. The video inputs shall accept composite video as defined in EIA 170. Sensor controls shall be mounted on the front panel or in an adjacent rack panel. The sensor shall not require external sync for operation. One alarm output shall be provided for each video input. The number of video inputs and alarm outputs shall be as shown. Components, cables, power supplies, and other items needed for a complete video motion sensor shall be provided. Sensor equipment shall be rack mounted in a standard 19 inch rack as described in EIA ANSI/EIA-310-D. The rack shall include hardware required to mount the sensor components.

## 2.8 ENTRY CONTROL DEVICES

### 2.8.1 Card Readers and Credential Cards

Entry control card readers shall use unique coded data stored in or on a compatible credential card as an identifier. The card readers shall be swipe-through with PIN identification and proximity type, where indicated and shall incorporate built-in heaters or other cold weather equipment to extend the operating temperature range as needed for operation at the site.

Communications protocol shall be compatible with the local processor. The Contractor shall furnish card readers to read magnetic stripe and active proximity detection, respectively to where indicated on the drawings, entry cards, and the matching credential cards. The cards shall contain coded data arranged as a unique identification code stored on or within the card, and of the type readable by the card readers. The Contractor shall include within the card's encoded data, a non-duplicated unique facility identification code common to all credential cards provided at the site. Enrollment equipment to support local encoding of badges including cryptographic and other internal security checks shall be supplied.

#### 2.8.1.1 Magnetic Stripe with PIN

Magnetic stripe card readers shall read credential cards which meet the requirements of ISO 7810, ISO 7811-1, ISO 7811-2, ISO 7811-3, ISO 7811-4, and ISO 7811-5. Magnetic stripe card readers shall also require that a Personal Identification Number (PIN) be input for access. Magnetic stripe credential cards shall use single layer 4000 ersted magnetic tape material.

The magnetic tape material shall be coated with Teflon and affixed to the back of the credential card near the top. The number of bits per inch, number of tracks, and number of unique codes available for the magnetic tape shall be in accordance with ISO 7811-1, ISO 7811-2, ISO 7811-3, ISO 7811-4, and ISO 7811-5.

#### 2.8.1.2 Proximity

Proximity card readers shall use active proximity detection and shall not require contact with the proximity credential card for proper operation. Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction and receive and decode a unique identification code number transmitted from the credential card. The card reader shall read proximity cards in a range from 0 inches to at least 6 inches from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.

#### 2.8.1.3 Card Reader Display

The card readers shall include an LED or other visual indicator display. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.

#### 2.8.1.4 Card Reader Response Time

The card reader shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less, from the time the card reader finishes reading the credential card until a response signal is generated.

#### 2.8.1.5 Card Reader Power

The card reader shall be powered from the source as shown and shall not dissipate more than 5 Watts.

#### 2.8.1.6 Card Reader Mounting Method

Card readers shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

#### 2.8.1.7 Credential Card Modification

Entry control cards shall be able to be modified by lamination or direct print process during the enrollment process for use as a picture and identification badge as needed for the site without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the type badge holder used at the site.

#### 2.8.1.8 Card Size and Dimensional Stability

Credential cards shall be 2-1/8 x 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

#### 2.8.1.9 Card Materials and Physical Characteristics

The credential card shall be abrasion resistant, non-flammable, and present no toxic hazard to humans when used in accordance with manufacturer's instructions. The credential card shall be impervious to solar radiation and the effects of ultra-violet light.

#### 2.8.1.10 Card Construction

The credential card shall be of core and laminate or monolithic construction. Lettering, logos and other markings shall be hot stamped into the credential material or direct printed. The credential card shall incorporate holographic images or phosphorous ink as a security enhancement. The Contractor shall provide a means to allow onsite assembly and lamination of credential cards by Government personnel.

#### 2.8.1.11 Card Durability and Maintainability

The credential cards shall be designed and constructed to yield a useful

lifetime of at least 5000 insertions or swipes or 5 years whichever results in a longer period of time. The credential card shall be able to be cleaned by wiping the credential card with a sponge or cloth wet with a soap and water solution.

## 2.8.2 Keypads

Entry control keypads shall be the combination type with swipe card reader. Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in random scrambled order. Communications protocol shall be compatible with the local processor.

### 2.8.2.1 Keypad Display

Keypads shall include an LED or other type of visual indicator display and provide visual status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

### 2.8.2.2 Keypad Response Time

The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.

### 2.8.2.3 Keypad Power

The keypad shall be powered from the source as shown and shall not dissipate more than 150 Watts.

### 2.8.2.4 Keypad Mounting Method

Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

### 2.8.2.5 Keypad Duress Codes

Keypads shall provide a means for users to indicate a duress situation by entering a special code.

## 2.8.3 Card Readers With Integral Keypad

### 2.8.3.1 Magnetic Stripe

The magnetic stripe card reader, as specified in paragraph Card Readers And Credential Cards and paragraph Magnetic Stripe, shall be equipped with integral keypads as specified in paragraph Keypads.

### 2.8.3.2 Proximity

The proximity card reader, as specified in paragraph Card Readers And Credential Cards and paragraph Proximity, shall be equipped with integral keypads as specified in paragraph Keypads.

#### 2.8.4 Personal Identity Verification Equipment

Entry control personnel identity verification equipment shall use a unique personal characteristic or unique personal physiological measurement to establish the identity of authorized, enrolled personnel. Personnel identity verification equipment shall include a means to construct individual templates or profiles based upon measurements taken from the person to be enrolled. This template shall be stored as part of the System Reference Database Files. The stored template shall be used as a comparative base by the personnel identity verification equipment to generate appropriate signals to the associated local processors.

#### 2.8.5 Portal Control Devices

##### 2.8.5.1 Push-button Switches

The Contractor shall provide momentary contact, back lighted push buttons and stainless steel switch enclosures for each push button as shown. Switch enclosures shall be suitable for flush, or surface mounting as required. Push buttons shall be suitable for flush mount in the switch enclosures. The push button switches shall meet the requirements of NEMA 250 for the area in which they are to be installed. Where multiple push buttons are housed within a single switch enclosure they shall be stacked vertically with each push button switch labeled with 1/4 inch high text and symbols as required. The push button switches shall be connected to the local processor associated with the portal to which they are applied and shall operate the appropriate electric strike, electric bolt or other facility release device. Switches shall have a minimum continuous current rating of 10 Amperes at 120 Vac or 5 Amperes at 240 Vac. The push button switches shall have double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.

##### 2.8.5.2 Panic Bar Emergency Exit With Alarm

Entry control portals shall include panic bar emergency exit hardware as shown. Panic bar emergency exit hardware shall provide local alarm annunciation and alarm communications to the portal's local processor. The panic bar shall include a conspicuous warning sign with 1 inch high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated. Operation of the panic bar hardware shall generate an intrusion alarm. The panic bar, except for local alarm annunciation and alarm communications, shall depend upon a mechanical connection only and shall not depend upon electric power for operation. The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt.

##### 2.8.5.3 Electromagnetic Lock

Electromagnetic locks shall contain no moving parts and shall depend solely upon electromagnetism to secure a portal by generating at least 1200 pounds of holding force. The electromagnetic lock shall release automatically in case of power failure and shall require manual reset to resume normal function. The lock shall interface with the local processors without external, internal or functional alteration of the local processor. The electromagnetic lock shall incorporate an end of line resistor to

facilitate line supervision by the system.

a. Armature: The electromagnetic lock shall contain internal circuitry to eliminate residual magnetism and inductive kickback. The actuating armature shall operate on 12 or 24 Volts dc and shall not dissipate more than 12 Watts. The holding current shall be not greater than 500 milliamperes. The actuating armature shall take not more than 300 milliseconds to change the status of the lock from fully secure to fully open or fully open to fully secure.

b. Tamper Resistance: The electromagnetic lock mechanism shall be encased in hardened guard barriers to deter forced entry.

c. Mounting Method: The door electromagnetic lock shall be suitable for use with single and double door with mortise or rim type hardware as shown, and shall be compatible with right or left hand mounting.

## 2.9 ENTRY CONTROL SOFTWARE

### 2.9.1 Interface Device

The entry control software shall control passage. The decision to grant or deny passage shall be based upon identifier data to be input at a specific location. If all conditions are met, a signal shall be sent to the input device location to activate the appropriate electric strike, bolt, electromagnetic lock or other type of portal release or facility interface device.

### 2.9.2 Operator Interface

Entry control operation shall be entirely automatic under control of the central station and local processors except for simple operations required for map display, alarm acknowledgment, zone and portal status change operations, audible or visual alarm silencing and audio annunciation. The system shall immediately annunciate changes in zone and portal status. The alarm printer shall print a permanent record of each alarm and status change. The map displays or graphics screens shall display the current status of system zones and portals. The central station shall immediately display the current status of any zone or portal upon command. While the system is annunciating an unacknowledged zone or portal alarm, keyboard operations at the central station, other than alarm acknowledgment, shall not be possible. The system shall provide the capability to change zone and portal status from alarm (after alarm acknowledgment) or access to secure; from alarm (after alarm acknowledgment) or secure to access, or from access to secure by simple control operations. If the operator attempts to change zone status to secure while there is an alarm output for that zone or portal, the system shall immediately annunciate an alarm for that zone or portal.

### 2.9.3 Entry Control Functions

#### 2.9.3.1 Multiple Security Levels

The system shall have multiple security levels. Each of the security levels shall be delineated by facility barriers. Access to each security level shall be through portals in the facility barriers using designated entry control procedures. The system shall provide at least 8 security levels. Any attempt to access an area beyond an individual's security level shall initiate an access denial alarm.

#### 2.9.3.2 Two person rule

The system shall provide a 2 person rule feature. When a portal is designated as a 2 person rule portal, it shall not allow passage unless 2 valid identifiers are presented in the proper sequence. The scheme shall be designed so that only the first 2 valid identifiers and the last 2 valid identifiers pass together.

#### 2.9.3.3 Anti-Passback

Portals as shown shall incorporate anti-passback functions. Anti-passback functions and identifier tracking shall be system-wide for portals incorporating anti-passback. Once an authorized, enrolled individual has passed through a portal using entry control procedures, the system shall not allow use of the same identifier to pass through any portal at the same security level until the individual has egressed through a portal at this same security level using entry control procedures. Any attempt to violate anti-passback procedures shall initiate an access denial alarm. Portals that do not incorporate anti-passback functions shall allow egress from the area by a push-button switch for activation of the facility interface device. Portal egress switch shall be located as shown.

#### 2.9.3.4 Immediate Access Change

The system shall provide functions to disenroll and deny access to any identifier or combination of identifiers without consent of the individual or recovery of a credential. The design of the system shall provide entry change capability to system operators and managers with appropriate passwords at the system operator or enrollment consoles.

#### 2.9.3.5 Multiple Time Zones

The system shall provide multiple time zone entry control. Personnel enrolled in the system shall only be allowed access to a facility during the time of day they are authorized to access the facility. Time zone access control shall also include the ability to specify beginning and ending dates that an individual will be authorized to access a facility. The system shall provide automatic activation and deactivation of entry authorization. The design of the system shall provide at least 24 time zones with overlapping time zones. The system shall provide a means for system operators with proper password clearance, to define custom names for each time zone, and to change the time zone's beginning and ending times through the system operator and enrollment interfaces. The system shall automatically disenroll individuals at the end of their predefined facility access duration. Any attempt during a 24 hour period by an individual or an identifier to gain facility entry outside of the authorized time zone shall initiate an entry denial alarm.

#### 2.9.3.6 Guard Tour

The system shall provide guard tour monitoring capability. The system shall monitor a security guard's progress and timing during performance of routine inspections. The system shall provide a means for operators and managers with appropriate password levels to define facility check points, and create time windows of the shortest and longest times necessary to get from one check point on the tour to the next. The time window between check points shall be adjustable over a range of at least 1 minute to 1 hour with a resolution of at least 1 minute. The system shall annunciate

an alarm if the guard does not log in at the next check point within the allotted time window. Time measurements shall be reset at each terminal device check point when the guard logs in so that cumulative time variations do not result in false alarms. The guard tour shall have a random start/stop function so that a tour may start from any designated station at any designated time, and in either a forward or reverse direction to ensure that patrol patterns cannot be deduced by observation. The system operator shall be able to reposition or halt a guard during a tour to allow time for investigations to be made. The system guard tour feature shall be able to store at least 128 programmed guard tours in memory with at least 12 tours active at any one time, and at least 24 check points for each tour. Guard tours shall be configured as needed for the site.

#### 2.9.3.7 Elevator Control

The system shall control elevator operation with entry control terminal devices. The elevator's standard control equipment, components, and actuators shall serve as the facility interface. System components and subsystems shall interface to standard elevator control equipment without modification of the elevator control equipment. The system shall provide means to define access controlled floors of a facility, deny access to these floors by unauthorized individuals, and implement all other system functions as specified.

#### 2.9.4 Electronic Entry Control System Capacities

The system shall be designed and configured to provide the following capacities.

##### 2.9.4.1 Enrollees

The system shall be configured for 7,000 enrollees. The system shall provide a facility-tailorable reference file database containing personal, access authorization, identifier and verification data for each enrollee as required.

##### 2.9.4.2 Transaction History File Size

The system capacity shall be at least the amount of transactions for the system during 1 year without any loss of transaction data.

#### 2.9.5 Entry Control System Alarms

The system shall annunciate an alarm when the following conditions occur. Alarms shall be annunciated at the console both audibly and visually. An alarm report shall also be printed on the system printer. The alarm annunciation shall continue until acknowledged by the system operator. Only 1 control key shall be needed to acknowledge an alarm. The system shall control, monitor, differentiate, rank, annunciate, and allow operators to acknowledge, in real time, alarm signals generated by system equipment. The system shall also provide a means to define and customize the annunciation of each alarm type. The system shall use audio and visual information to differentiate the various types of alarms. Each alarm type shall be assigned an audio and a unique visual identifier.

##### 2.9.5.1 Duress

The system shall annunciate a duress alarm when a duress code is entered at

a keypad or a duress switch is activated. Duress alarms shall be annunciated in a manner that distinguishes them from all other system alarms. Duress alarms shall not be annunciated or otherwise indicated locally nor shall a duress alarm cause any special or unusual indications at the portal or area initiating the duress alarm. Individual privileges shall be carried out the same as an authorized entry to the protected area.

Duress alarms shall only be annunciated at the central station and remote displays. Alarms shall be annunciated on the monitor and shall be logged on the printer.

#### 2.9.5.2 Guard Tour

The system shall annunciate an alarm when a security guard does not arrive at a guard tour check point during the defined time window or if check points are passed out of the prescribed order.

#### 2.9.5.3 Entry Denial

The system shall annunciate an alarm when an attempt has been made to pass through a controlled portal and entry has been denied.

#### 2.9.5.4 Portal Open

The system shall annunciate an alarm when an entry controlled portal has been open longer than a predefined time delay. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.9.5.5 Bolt Not Engaged

The system shall annunciate an alarm when the bolt at an entry controlled portal has been open longer than a predefined time delay and generate an entry control alarm. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.9.5.6 Strike Not Secured

The system shall annunciate an alarm when the strike at an entry controlled portal has been left unsecured longer than a predefined time delay and generate an entry control alarm. The time delay shall be adjustable, under operator control, over a range of at least 1 second to 1 minute with a maximum resolution of 1 second.

#### 2.9.5.7 Alarm Shunting/System Bypass

The system shall provide a means to ignore operator selected alarm types at operator selected portals in order to allow standard entry control procedures to be bypassed (shunted). Predefined alarm shunting shall only be available to system operators with the proper password. The system shall also provide for predefined alarm shunting based upon time zones. This capability shall only apply to the entry control alarm type.

### 2.10 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government furnished equipment. Wiring shall meet NFPA 70 standards.

#### 2.10.1 Above Ground Sensor Wiring

Sensor wiring shall be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. Multiconductor wire shall have an outer jacket of PVC.

#### 2.10.2 Direct Burial Sensor Wiring

Sensor wiring shall be 20 AWG minimum, twisted and shielded, 2, 3, 4, or 6 pairs to match hardware. The construction of the direct burial cable shall be as specified in Section 16792 WIRELINE DATA TRANSMISSION SYSTEM.

#### 2.10.3 Local Area Network (LAN) Cabling

LAN cabling shall be in accordance with EIA ANSI/TIA/EIA-568-A, category 5.

### PART 3 EXECUTION

#### 3.1 GENERAL REQUIREMENTS

The Contractor shall install all system components, including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown. The contractor shall furnish necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

##### 3.1.1 Installation

The contractor shall install the system in accordance with the standards for safety, NFPA 70, UL 681, UL 1037 and UL 1076, and the appropriate installation manual for each equipment type. Components within the system shall be configured with appropriate service points to pinpoint system trouble in less than 20 minutes. Minimum size of conduit shall be 1/2 inch. DTS shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. Flexible cords or cord connections shall not be used to supply power to any components of the system, except where specifically noted. All other electrical work shall be as specified in Section 16415 and as shown.

##### 3.1.2 Enclosure Penetrations

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in a manner that does not damage the cable.

##### 3.1.3 Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc., shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

### 3.1.4 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report any changes in the site, or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

### 3.1.5 Existing Equipment

The Contractor shall connect to and utilize existing base Vindicator equipment. The Contractor shall perform a field survey, including testing and inspection of all existing system equipment and DTS intended to be incorporated into the system, and furnish a report to the Government as part of the site survey report as defined in paragraph Group II Technical Data Package. For those items considered nonfunctioning, the report shall include specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to his equipment and work. The Government is responsible for maintenance and the repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

### 3.1.6 Installation Software

The Contractor shall load software as specified and required for an operational system, including data bases and specified programs. Upon successful completion of the endurance test, the Contractor shall provide original and backup copies on CD-ROM of all accepted software, including diagnostics.

## 3.2 SYSTEM STARTUP

Satisfaction of the requirements below does not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment. The Contractor shall not apply power to the system until after:

a. System equipment items and DTS have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.

c. System wiring has been tested and verified as correctly connected.

d. System grounding and transient protection systems have been verified as properly installed.

e. Power supplies to be connected to the system have been verified as

the correct voltage, phasing, and frequency.

### 3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed system; and are approved by the Contracting Officer. These representatives shall be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet the contractual requirements.

### 3.4 TESTING

#### 3.4.1 General Requirements for Testing

The Contractor shall provide personnel, equipment, instrumentation, and supplies necessary to perform site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during predelivery, performance verification and endurance testing, shall be turned over to the Government at the conclusion of each phase of testing, prior to Government approval of the test.

#### 3.4.2 Predelivery Testing

The Contractor shall assemble the test system as specified, and perform tests to demonstrate that performance of the system complies with specified requirements in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during predelivery testing, including results of each test procedure, shall be delivered to the Government at the conclusion of predelivery testing, prior to Government approval of the test. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.

#### 3.4.3 Test Setup

The predelivery test setup shall include the following:

- a. All central station equipment.
- b. At least 1 of each type DTS link, but not less than 2 links, and associated equipment to provide a fully integrated system.
- c. The number of local processors shall equal the amount required by the site design.
- d. At least 1 of each type sensor used.
- e. Enough sensor simulators to provide alarm signal inputs to the system equal to the number of sensors required by the design. The alarm signals shall be manually or software generated.

- f. At least 1 of each type of terminal device used.
- g. At least 1 of each type of portal configuration with all facility interface devices as specified or shown.
- h. Equipment as specified in Section 16751 CLOSED CIRCUIT TELEVISION SYSTEMS when required.
- i. The Contractor shall prepare test procedures and reports for the predelivery test, and shall deliver the predelivery test procedures to the Government for approval. The final predelivery test report shall be delivered after completion of the predelivery test.

#### 3.4.4 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTS operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations, including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

#### 3.4.5 Performance Verification Test

The Contractor shall demonstrate that the completed system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until after receipt by the Contractor of written permission from the Government, based on the Contractor's written report. The report shall include certification of successful completion of testing as specified in paragraph Contractor's Field Testing, and upon successful completion of training as specified. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

#### 3.4.6 Endurance Test

a. General: The Contractor shall demonstrate system reliability and operability at the specified throughput rates for each portal, and the Type I and Type II error rates specified for the completed system. The contractor shall calculate false alarm rates and the system shall yield false alarm rates within the specified maximums at the specified probability of detection. The endurance test shall be conducted in phases as specified. The endurance test shall not be started until the Government notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. The Contractor shall provide 1 operator to operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing, in addition to any Government personnel that may be

made available. The Government may terminate testing at any time the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. The Contractor shall verify the operation of each terminal device during the last day of the test. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

b. Phase I Testing: The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during Phase I testing, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

c. Phase II Assessment: After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the jobsite to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, or may require that Phase I be repeated. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

d. Phase III Testing: The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

e. Phase IV Assessment: After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the jobsite to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, and may require that Phase III be repeated. The Contractor shall not commence any required retesting until after receipt of written notification by Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

f. Exclusions: The Contractor will not be held responsible for failures in system performance resulting from the following:

(1) An outage of the main power in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished and that automatic shutdown and restart of the ESS performed as specified.

(2) Failure of a Government furnished communications circuit, provided that the failure was not due to Contractor furnished equipment, installation, or software.

(3) Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

(4) The occurrence of specified nuisance alarms.

(5) The occurrence of specified environmental alarms.

### 3.5 RELIABILITY CALCULATION

This exponential calculation depends on the test duration and assumes that the Mean Time Between Failures (MTBF) does not change after each repair; and that the probability of failure is constant throughout the useful life of the component regardless of how many failures the system has experienced. This calculation does not account for effects of aging.

#### 3.5.1 Definition of Reliability

System reliability is calculated in terms of overall MTBF where the component reliability furnished by vendors is already expressed as MTBF. The mathematical combination of the component MTBF values is defined as the system reliability,  $R(t)$ ; the probability that the system will perform its function during a given time period under specified conditions. In this calculation, each component reliability is determined; the component reliabilities are combined as dictated by the system configuration; and the overall MTBF is computed as follows:

$R(t) = e^{-t/MTBF}$ ; where:

MTBF = mean time between failure

t = duration of test period

e = base of natural logarithms

When  $t/MTBF$  is less than 0.1, the reliability can be approximated as follows:

$R(t) = 1 - (t/MTBF)$ : A specific reliability value can be interpreted by noting that a value of  $R(t)$  greater than  $1/e$  (which equals 0.37) indicates that the MTBF value is greater than the test duration.

#### 3.5.2 Series and Parallel Components

Components are in series if failure of 1 component causes a system failure.

Reliability of components in series is a product of the individual reliabilities:

$R = 1 - (r_1)(r_2)(r_3)\dots(r_n)$ . If components in a system are redundant (parallel), reliability is computed as follows:

$R = 1 - \{(1-r_1)(1-r_2)\dots(1-r_n)\}$ . If a system has parallel components, an equivalent series reliability is computed for each set of parallel components. The reliability of the system is then computed as the product of series and equivalent series reliabilities.

### 3.5.3 Calculation Procedure

The Contractor shall prepare a table showing the following data:

- a. Name and quantity of each component.
- b. Each component identified as series or parallel. (For example, if there are 2 printers, the failure of 1 will not cause a system failure).
- c. MTBF for each component.
- d. Single unit reliability:  $R = e^{-t/MTBF}$ , where  $t = 1,000$  hour test period.
- e. Total Component Reliability (TCR) where  $TCR = R^n$ , and  $n =$  number of components. For parallel components,  $TCR = 1 - (1-R)^n$ , where  $n =$  number of components.
- f. Cumulative Reliability (CUMR) is the product of total component reliability; for example:  $CUMR_4 = (TCR_1) (TCR_2) (TCR_3) (TCR_4) = (CUMR_3) (TCR_4)$
- g. Cumulative MTBF =  $-1,000/LN (CUMR)$ ; where  $LN (CUMR)$  is the natural logarithm of (CUMR). As an example:  $CUM.MTBF = -1,000/LN (CUMR_4)$

### 3.5.4 Sample Calculations

MTBF is not calculated for sensors and controls. Input/Output functions are part of the local processor. Any Input/Output failure not attributable to sensors and controls constitutes a local processor failure and is thus reflected in the local processor MTBF. MTBF for other components are based on the lowest values provided by vendors. The calculation shall be based on the following configuration:

- a. All central station equipment.
- b. Data Transmission System (DTS) equipment associated with one DTS circuit, but excluding the circuit itself.
- c. Sixteen local processors with all the functions as specified in paragraph Local Processor.
- d. Four representative types of devices, per local processor.

-- End of Section --

## SECTION 13722

## SOUND MASKING SYSTEM

04/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2002) National Electrical Code

## 1.2 SYSTEM DESCRIPTION

The sound masking system shall consist of, but not be limited to, electronic noise generators, mixers, amplifiers, wiring, equalizers, controls, transducers, speakers, and auxiliary components to generate, amplify, distribute, and reproduce digitally synthesized and stabilized pink background noise for sound masking for security in zones of coverage. Provide all equipment and devices that is required for a complete sound masking system as specified herein and in accordance with the the Defense Intelligences Agency criteria.

## 1.2.1 Definitions

A. Test and Calibration Conditions: Spaces completely furnished but unoccupied, lights and HVAC systems on, HVAC system testing and balancing completed, ceiling components in place.

B. Covered Spaces: Exterior windows where transducers are installed. Work spaces. Spaces above drop ceilings. Spaces below raised access flooring.

C. Pink Noise: Random noise signal with equal energy in each octave.

D. Sound Masking: Covering up of one sound by another.

## 1.2.2 Multi-Channel System

The system shall provide two channels for distribution over an audio network to speakers and glass transducers as indicated. Each channel shall be separate, and equipment for each channel shall be identical, except for alternate program inputs which shall be suitable for the alternate source specified. The system shall include electronic noise generators, mixers, amplifiers, wiring, equalizers, controls, transducers, and auxiliary components and all accessories required.

## 1.2.3 System Performance

The system shall provide even sound distribution throughout the designated area and zones. The system shall be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) to any location in the area at an acoustic distortion level below 5

percent total harmonic distortion (THD). Additional performance shall be:

A. Signal Levels: Individually adjustable for each of 14 one-third octave bands centered at 200 through 4000 Hz, for sound-masking noise channels.

B. Sound-Power Level Produced by System: Match NC 40 contour between 400 and 2000 Hz, with smooth roll-off above and below those frequencies.

1. Initial Level: 40 dB, A-weighted.
2. Final Adjusted Level: 40 to 50 dB, A-weighted. Determine final level for each space individually by measurement as specified in Part 3.
3. Measurements: Made under calibration conditions.

C. Maximum Local Variance of Sound-Power Level: 6 dB for the 500-Hz octave band and 3 dB for the 1000-, 2000-, and 4000-Hz octave bands for 75 percent of the locations in covered spaces.

D. Maximum Average Range of Sound-Power-Level Deviation: 2 dB in the 250-, 2000-, and 4000-Hz octave bands and 1.5 dB for the 500- and 1000-Hz octave bands for all locations.

E. Directional Effect: People in covered spaces under calibration conditions cannot determine source of masking sound.

G. Uniformity with Respect to Time: One-minute time-averaged sound-pressure level of any octave band of masking sound from 250 to 8000 Hz remains constant in any space to within a standard deviation of 2 dB when measured over a 30-minute period.

H. Sound Quality: No audible hum or noise from this system in covered spaces when noise generators are off and power amplifiers are on with input volume controls set at 50 percent.

### 1.3 CONTRACTOR QUALIFICATIONS

The system shall be installed by an experienced firm regularly engaged in the installation of high secured installation sound masking systems for the Department of Defense. The contractor shall have a minimum of five years experience installing, testing, and calibrating high secured installations sound masking systems on at least ten different systems. The Contractor must be certified by the manufacturer of the sound masking equipment to install, calibrate and test the complete system. Certification shall be submitted to the Contracting Officer for approval. Submit a list of recent projects and point of contacts with telephone numbers, a minimum of ten, for reference and verification of contractor qualifications.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sound Masking System; G, AE

Detail drawings consisting of a complete list of equipment and

material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers and transducers. The Contractor shall check the layout based on the actual speakers and transducers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

#### SD-03 Product Data

Spare Parts; G, RE

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

#### SD-06 Test Reports

Approved Test Procedures; G, AE

Test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; G, AE

Test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system.

#### SD-07 Certificates

Components; G, AE

Copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components.

Materials and Equipment; GA.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of

Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

#### Sound Masking System Installer Qualification;; GA, AE

A certification that contains the names and the qualifications of people recommended to perform the sound masking system installation, testing, and calibrating, under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in the same types of installation. The Contractor shall provide at least one on site person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

#### SD-10 Operation and Maintenance Data

Sound Masking System, Data Package 3; G  
, AE

Submit data package in accordance with Section 01781, OPERATION AND MAINTENANCE DATA

#### 1.5 DELIVERY AND STORAGE

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

#### 1.6 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

#### PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

Material and equipment to be provided shall be the standard products of a manufacturer regularly engaged in the manufacture of such products, and shall essentially duplicate material and equipment that have been in satisfactory use at least 5 years. All components used in the system shall be commercial designs that comply with the requirements specified. Equipment shall be supported by a service organization that is within 100 miles of the site.

## 2.2 Component Modularity

Modular plug-in, heavy-duty, industrial-grade integrated circuit devices.

## 2.3 AC Power Supply

AC Supply Voltage Tolerance: 105 to 130 V with no degradation of system performance.

## 2.4 Power Line Surge Protection

Protection from Power Line Surges: Integral surge suppressors listed under UL 1449; complying with IEEE C62.41, Category B; and with the following features:

1. Suppression Level: 300 V.
2. Maximum Response Time: 5 nanoseconds.
3. Circuit: Multistage, using inductors and silicon-avalanche zener diodes or equivalent.
4. Indicator Lamp: Neon or light-emitting diode located on control panel and arranged to extinguish on failure of protection.
5. Fuses: Externally accessible.

## 2.5 System Components Mounting

All electronic components (i.e. amplifiers, equalizers, volume controls, etc.) shall be suitable for mounting in standard 19-inch racks, with connections at rear and controls front of the rack panel and protected by a full length, plastic or glass side hinged door.

## 2.6 NOISE GENERATOR AND FILTER UNITS

Noise generator and filter unit shall have the following minimum characteristics:

- A. Pink Noise Generator: Output octave bands from 30 to 4000 Hz.
- B. Filters for One-Third Octave Bands: Adjustable from 10 dB of boost to 10 dB of cut at each center frequency.
- C. High-Pass Filter: Approximate range of cutoff adjustment is 37 to 400 Hz.
- D. Low-Pass Filter: Approximate range of cutoff adjustment is 3.4 to 20 kHz.
- E. High-Cut Filter: Approximate range of cutoff adjustment is 180 to 9000 Hz with slope varying to 12 dB per octave.

## 2.7 PROGRAMMABLE AUDIO-LEVEL CONTROL UNIT

The programmable audio-level control shall have the following minimum characteristics:

A. Automatic Sound-Power-Level Changes: Six system channel changes, four times per day, and capable of different time settings for each day of week.

B. Level Changes: Programmable from front panel of unit, and automatically incremented over a period long enough for sound-level variations to be imperceptible to occupants of covered spaces.

C. Program Memory: Nonvolatile for one year, minimum, without power. When re-energized after a power outage, control starts at zero level and automatically advances system sound level at same rate used for programmed level changes.

## 2.8 MIXER-PREAMPLIFIER

Mixer-preamplifier shall as a minimum conform to the following specifications:

Rated Output:	18 dB
Frequency Response:	Plus or Minus 1 dB, 20 - 20,000 Hz
Distortion:	Less than 0.2 percent, 20 - 20,000 Hz
Signal to noise:	Microphone - 60 dB Aux - 70 dB
Inputs:	5 independent balanced low-impedence, transformer-isolated
Input Sensitivity:	Microphone - 0.003 volts Aux - 0.125 volts Magnetic Cartridge - 0.0005 volts
Input Channel	
Isolation:	80 dB minimum
Tone Controls:	Plus or Minus 10 dB range at 50 and 15,000 Hz
Power Requirement:	110-125 Vac 60 Hz

## 2.9 EQUALIZER

The equalizer shall be catalog number SMS200 as manufactured by Biamp or approved equal.

## 2.10 POWER AMPLIFIERS

Power amplifiers as a minimum conform to the following specifications:

Rack mounted type in standard 19 inch rack.

Rated power output: 250 watts RMS  
 Frequency Response: Plus or Minus 2 dB, 60-13,000 Hz  
 Distortion: Less than 2 percent at RPO, 600-13,000 Hz  
 Input Impedance: 50 k ohm unbalanced  
 Signal to Noise Ratio: 60 dB or greater, at rated output.  
 Output Impedance: 83.3, 10.4, 8.0, and 4.0 ohms  
 Output voltage: 70.7, 25, 22, and 15.5 volts  
 Power Requirement: 110-125 Vac 60 Hz

## 2.11 TRANSDUCERS

### 2.11.1 WINDOW GLASS TRANSDUCERS

Provide piezo type window mounted glass transducers as manufactured by Atlas-Soundolier or approved equal, for resonting.

## 2.7 LOUDSPEAKERS

### 2.12 Cone Speaker

The cone speaker shall as a minimum conform to the following specifications:

Minimum Axial Sensitivity: 45 dB.

Size: 8 inches with 1-inch (25-mm) voice coil

Dispersion Angle: 100 degrees.

Application: Ceiling or Pendant

Frequency range: 60 to 12,000 Hz

Power Rating: Normal - 10 watts

Voice Coil Impedance: 8 ohms

Line Matching  
 Transformer Type: 25/70 volt line

Capacity: 2 watts

Magnet: 8 ounces or greater

Primary Taps: 0.5, 1, and 2 watts

Primary Impedance: 25 volts - 1250, 625, and 312 ohms  
 70 volts - 10k, 5k, and 2.5k ohms

Frequency Response: 30 - 20,000 Hz

Insertion Loss: Less than 1 dB

## 2.13 SPEAKER ENCLOSURES

Provide speakers mounted in ceiling mounted backcans, flush in ceiling with baffle and trim or mount pendant mounted above ceiling as specified, in backcan, baffle and trim.

## 2.14 SWITCHES AND CONTROLS

### 2.14.1 REMOTE TRANSDUCER CONTROLS

Provide remote volume controls with detented 3 dB steps and an OFF position. Provide with VU meter. The controls shall be rack and gang mounted and labelled respective to the transducer controlled. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be 10 watts. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

### 2.14.2 REMOTE LOUDSPEAKER VOLUME CONTROLS

Provide remote volume controls shall be an auto transformer type with detented 3 dB steps and an OFF position. Provide with VU meter. The controls shall be rack and gang mounted and labelled respective to the speaker controlled. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be 10 watts. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

## 2.15 EQUIPMENT CABINETS

Cabinets, freestanding modular type, 16 gauge steel construction treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with 19 inch panel mounting. Provide cabinet with grounding bar, rack mounted 550 CFM fan with filter and a surge protected power strip with 6 duplex 20 amp receptacles.

## 2.16 SPEAKER AND TRANSDUCER CABLE

Cables shall be of the gauge required depending upon the cable run length. In no case shall any cable be used which is smaller than 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.009 inch. Cables shall be shielded with a 34-gauge tinned soft copper strand formed into a braid. Cables shall be jacketed with a Fluoropolymer compound. The jacket thickness shall be 0.0200 inch minimum.

## 2.17 LAPTOP TUNER

The contractor shall provide a complete portable "laptop" type computer/tuner to tune and equalize the system. Provide all required software and license to the Contracting Officer.

## PART 3 EXECUTION

### 3.1 INSTALLATION

All equipment shall be installed as indicated and specified, and in accordance with the manufacturer's recommendations and in accordance with Defense Intelligence Agency and Langley Air Force Base Security requirements. All electronic components shall be rack mounted type. Volume controls shall be ganged, labelled and rack mounted in the rack with the electronic components. Equipment mounted out-of-doors or subject to inclement conditions shall be weatherproofed.

#### 3.1.1 Speaker Assemblies

Above ceiling speakers: Suspend with chains from building structure above ceilings so bottom of assembly is 6 to 8 inches above upper plane of finished ceiling material. Ceiling mounted speakers: Flush mount in drop ceiling complete with trim, backcan and accessories. Use eyebolts on speaker assemblies for attachment. Suspend independently of supports for components of other building systems.

#### 3.1.2 Speaker Connections

For two- or three-channel systems, connect speaker assemblies alternatively so masking sound is redundant throughout zones of coverage.

#### 3.1.3 Impedance Matching

Impedance Matching: For system components, including connecting cable, provide end-to-end level and impedance-matched signal paths. Use matching networks and balancing devices at connections where necessary to avoid mismatches.

#### 3.1.4 Equipment Cabinets

Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets. Cabinets, wall-mounted modular type. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

#### 3.1.5 Wiring

Wiring shall be installed in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring for grounding, line level, speaker, transducers and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated at only one end.

### 3.2 GROUNDING

All grounding practices shall comply with NFPA 70. Equipment shall be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panelboard ground bus utilizing a #8 conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

### 3.3 Field Testing, Installation and Report

The contractor shall field test and report and make all necessary adjustments to the system, to provide a complete sound masking system. Provide written reports of all test and adjustments to the Contracting Officer. Include the following as a minimum:

1. Operational Test: Start system to confirm proper operation. Remove malfunctioning units, re-place with new units, and retest. Make initial sound spectrum and sound level adjustments for each zone.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
4. Pretesting: Tune, align, and adjust system and pretest components, wiring, and functions to verify they comply with specified material, installation, and performance requirements. Correct deficiencies and retest until satisfactory performance and conditions are achieved.
5. Masking Sound-Power-Level Adjustments: Adjust independently for each space to minimum level between 40 and 50 dB that will provide speech privacy between adjacent workstations while complying with other system requirements.

### 3.4 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. The Contractor shall notify the Contracting Officer 15 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross talk or noise from other links or nondesignated units. Schedule tests after pretesting has been successfully completed. Include the following:

1. Perform tests as specified below, as required by ASTM E 1041, and as required to verify performance specified in "System Description" Article in this Section.
2. Instrumentation: Use a professional-quality, sound-level meter with octave-band filters and documentation of recent calibration against recognized standards.
3. Record test observations, readings, and corrective actions.
4. System Tests: Include the following for each system zone:
  - a. Transducer Circuit Impedance Test: Measure impedance at 1 kHz with amplifier disconnected, using a professional impedance meter or bridge. Locate and correct faults denoted by abnormal readings.
  - b. Ambient Sound-Level Tests: With system off, measure ambient sound level in one-third octave bands. Also measure ambient sound level as a single, wide-band, A-weighted reading.

c. Amplifier Noise Test: Check for performance specified in "System Description" Article with masking noise generator off and amplifiers on.

d. System Noise Test: With masking noise signal on and amplifiers adjusted at a working level 10 dB above ambient sound level, check for hum, buzz, rattle, or other operating deficiencies.

e. Spatial Uniformity Test: Measure sound level at locations no greater than 15 feet (4.6 m) o.c. throughout covered spaces to determine compliance with specified performance level.

f. Frequency Response Adjustment and Test: Adjust one-third octave frequency bands and other unit filters to provide response. Coordinate with NC 40 contour defined below between 200 and 2000 Hz, with smooth natural roll-off from those frequencies.

RELATIVE SOUND-POWER LEVEL - dB		
BAND	OPEN PLAN AREAS	ENCLOSED OFFICES
200	Plus 4	Minus 2
250	Plus 3	Minus 2
315	Plus 2	Minus 2.5
400	Plus 1	Minus 3
500	0	Minus 4
630	Minus 1	Minus 5
800	Minus 2	Minus 6
1000	Minus 3	Minus 7
1250	Minus 4	Minus 8.5
1600	Minus 5	Minus 10
2000	Minus 6	Minus 12

5. Adjust level of masking sound for each space so one-third octave band centered at 500 Hz has final selected sound-power level for that space. Measure deviation from listed values in one-third octave bands from 400 to 2000 Hz. Measured values must not deviate from those listed by more than 4 dB for open plan areas and 8 dB for enclosed offices. The total of individual band deviations in eight bands must not exceed 16 dB for open plan areas and 30 dB for enclosed offices.

6. Walk-through Test: Transducers shall be low profile and blend in with the decor.

7. Temporal Stability Test: Check for uniformity of time by measuring sound level in each of 14 octave bands at one-minute intervals over a 30-minute test period. Deviations must not exceed limits specified in "System Description" Article in Part 2.

E. Retest: Correct deficiencies identified by tests and observations and retest until meeting specified requirements.

F. Recording Control Settings and System Adjustments: Record final control settings and programming, and final tap setting of transducer and speaker matching transformers. Record final sound-level measurements and observations.

#### ADJUSTMENTS

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to

suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose without additional cost.

### 3.5 TRAINING

The Contractor shall conduct a training course for 4 members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of 4 hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to the start of the training course.

-- End of Section --

## SECTION 13930

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION  
04/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 135	(2001) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1998) Carbon Steel Track Bolts and Nuts
ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 53/A 53M	(2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 1999e1) Ductile Iron Castings
ASTM A 795	(2000) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM F 436	(2000) Hardened Steel Washers

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1999) Double Check Backflow Prevention Assembly
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## AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

AWWA C203 (1997; Addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AWWA EWW (1999) Standard Methods for the Examination of Water and Wastewater

AWWA M20 (1973) Manual: Water Chlorination Principles and Practices

## ASME INTERNATIONAL (ASME)

ASME B16.1 (1998) Cast Iron Pipe Flanges and Flanged Fittings

ASME B16.11 (1996) Forged Fittings, Socket-Welding and Threaded

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.3 (1998) Malleable Iron Threaded Fittings

ASME B16.4 (1998) Gray Iron Threaded Fittings

ASME B16.9 (1993) Factory-Made Wrought Steel Buttwelding Fittings

ASME B18.2.1 (1996) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (1987; R 1993) Square and Hex Nuts (Inch Series)

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a (1998) Approval Guide Fire Protection

FM P7825b (1998) Approval Guide Electrical Equipment

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71 (1997) Gray Iron Swing Check Valves, Flanges and Threaded Ends

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2000) Life Safety Code

NFPA 13 (1999) Installation of Sprinkler Systems

NFPA 1963 (1998) Fire Hose Connections

NFPA 24 (1995) Installation of Private Fire Service Mains and Their Appurtenances

## NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES

(NICET)

NICET 1014-7 (1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (1999) Building Materials Directory

UL Fire Prot Dir (1999) Fire Protection Equipment Directory

## 1.2 GENERAL REQUIREMENTS

Wet pipe sprinkler system shall be provided in all occupied areas of the building. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. The Contractor shall design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

### 1.2.1 Hydraulic Design

The system shall be hydraulically designed to discharge a minimum density of .10 gpm per square foot over the hydraulically most demanding 3,000 square feet of floor area. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

#### 1.2.1.1 Hose Demand

An allowance for exterior hose streams of 250 gpm shall be added to the sprinkler system demand at the fire hydrant shown on the drawings closest to the point where the water service enters the building.

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply with a static pressure of 58 kPa, and a flow of 761 GPM at a residual pressure of 32 kPa.

Water supply shall be presumed available at the base of the riser. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping. Two flow test are required. A flow test shall be performed at hydrant closest to building location on the fire protection/water distribution system prior to sprinkler system design and another flow test on the fire protection system after upgrade project is completed. If modified fire protection/water distribution system pressure exceeds NFPA 13 requirements, a pressure reducing valve shall be provided

### 1.2.2 Sprinkler Coverage

Sprinklers shall be uniformly spaced on branch lines. In buildings protected by automatic sprinklers, sprinklers shall provide coverage

throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13; as specified in NFPA 13 for extra hazard occupancy but not to exceed 225 square feet for light hazard or 130 square feet for ordinary hazard occupancies. Exceptions are as follows:

1) Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

### 1.3 COORDINATION OF TRADES

Piping offsets, fittings, and any other accessories required shall be furnished as required to provide a complete installation and to eliminate interference with other construction. Sprinkler shall be installed over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage.

### 1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Sprinkler System Shop Drawings; G, AE.

Three copies of the Sprinkler System Shop Drawings, no later than 21 days prior to the start of sprinkler system installation. The Sprinkler System Shop Drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers,

seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

As-Built Shop Drawings; .

As-built shop drawings, at least 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed and shall be on reproducible full-size mylar film.

#### SD-03 Product Data

Fire Protection Related Submittals; , G, AE..

A list of the Fire Protection Related Submittals, no later than 7 days after the approval of the Fire Protection Specialist.

Components and Equipment Data; G, AE.

Manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, a complete equipment list that includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; G, AE.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; , G, AE.

Spare parts data shall be included for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance

and testing of the products supplied by the Contractor shall be included.

Preliminary Tests Procedures; G, RE.

Proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests.

Final Acceptance Test Procedures; G, RE.

Proposed procedures for Final Acceptance Test, no later than 14 days prior to the proposed start of the tests.

On-site Training Schedule; G, RE.

Proposed On-site Training schedule, at least 14 days prior to the start of related training.

Preliminary Tests; G, RE.

Proposed date and time to begin Preliminary Tests, submitted with the Preliminary Tests Procedures.

Final Acceptance Test; G, RE.

Proposed date and time to begin Final Acceptance Test, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

Fire Protection Specialist Qualifications; G; RE.

The name and documentation of certification of the proposed Fire Protection Specialists, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system drawings and hydraulic calculations.

Sprinkler System Installer Qualifications; G, RE.

The name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the Fire Protection Specialist Qualifications.

#### SD-06 Test Reports

Preliminary Tests Report; G; RE.

Three copies of the completed Preliminary Tests Reports, no later than 7 days after the completion of the Preliminary Tests. The Preliminary Tests Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

Final Acceptance Test Report; G, RE.

Three copies of the completed Final Acceptance Tests Reports, no

later that 7 days after the completion of the Final Acceptance Tests. All items in the Final Acceptance Report shall be signed by the Fire Protection Specialist.

#### SD-07 Certificates

Fire Protection Specialist Inspection; G, RE.

Concurrent with the Final Acceptance Test Report, certification by the Fire Protection Specialist that the sprinkler system is installed in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports.

#### SD-10 Operation and Maintenance Data

Wet Pipe Sprinkler System; G, RE.

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour on-site response to a service call on an emergency basis.

### 1.7 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall be based on the water supply data shown on the drawings. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

### 1.8 FIRE PROTECTION SPECIALIST

Work specified in this section shall be performed under the supervision of

and certified by the Fire Protection Specialist. The Fire Protection Specialist shall be an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. The Fire Protection Specialist shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.9 SPRINKLER SYSTEM INSTALLER QUALIFICATIONS

Work specified in this section shall be performed by the Sprinkler System Installer. The Sprinkler System Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

#### 1.10 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.2 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

#### 2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and Equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM P7825a and FM P7825b. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM P7825a and FM P7825b

#### 2.4 UNDERGROUND PIPING COMPONENTS

##### 2.4.1 Pipe

Piping from a point 6 inches above the floor to a point 5 feet outside the building wall shall be ductile iron with a rated working pressure 150 psi

conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 5 feet outside the building walls shall comply with Section 02510A WATER DISTRIBUTION SYSTEM.

#### 2.4.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

### 2.5 ABOVEGROUND PIPING COMPONENTS

Aboveground piping shall be steel.

#### 2.5.1 Steel Piping Components

##### 2.5.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53/A 53M, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

##### 2.5.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Galvanized fittings shall be used for piping systems or portions of piping systems utilizing galvanized piping. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

##### 2.5.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer; segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

##### 2.5.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

##### 2.5.1.5 Bolts, Nut, and Washers

Bolts shall be squarehead conforming to ASME B18.2.1 and shall extend no less than three full threads beyond the nut with bolts tightened to the required torque. Nuts shall be hexagon type conforming to ASME B18.2.2.

Washers shall meet the requirements of ASTM F 436. Flat circular washers shall be provided under all bolt heads and nuts.

#### 2.5.2 Pipe Hangers

Hangers shall be listed in UL Fire Prot Dir or FM P7825a and FM P7825b and of the type suitable for the application, construction, and pipe type and sized to be supported.

#### 2.5.3 Valves

##### 2.5.3.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b.

##### 2.5.3.2 Check Valve

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM P7825a and FM P7825b. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

#### 2.6 ALARM CHECK VALVE ASSEMBLY

Assembly shall include an check valve, pressure gauges, testing valves, main drain, and other components as required for a fully operational system.

#### 2.7 ALARM INITIATING AND SUPERVISORY DEVICES

##### 2.7.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 10 gpm or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

##### 2.7.2 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

#### 2.8 FIRE DEPARTMENT CONNECTION

Fire department connection shall be flush type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2

inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

## 2.9 SPRINKLERS

Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be ordinary. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used.

### 2.9.1 Concealed Sprinkler

Concealed sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

### 2.9.2 Recessed Sprinkler

Upright sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

### 2.9.3 Flush Sprinkler

Flush sprinkler shall be chrome-plated quick-response type and shall have a nominal 1/2 inch or 17/32 inch orifice.

### 2.9.4 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, recessed quick-response type with nominal 1/2 inch orifice. Pendent sprinklers shall have a polished chrome white polyester finish.

### 2.9.5 Upright Sprinkler

Upright sprinkler shall be brass and shall have a nominal 1/2 inch orifice.

### 2.9.6 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.

## 2.10 DISINFECTING MATERIALS

### 2.10.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

### 2.10.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

## 2.11 ACCESSORIES

### 2.11.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be

representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

#### 2.11.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 3/4 inch and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

#### 2.11.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

#### 2.11.4 Identification Sign

Valve identification sign shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

### 2.12 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include pressure gauge test ports and OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 150 psi. The maximum pressure loss shall be 6 psi at a flow rate equal to the sprinkler water demand, at the location of the assembly. A test port for a pressure gauge shall be provided both upstream and downstream of the double check backflow prevention assembly valves.

## PART 3 EXECUTION

### 3.1 FIRE PROTECTION RELATED SUBMITTALS

The Fire Protection Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s). The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the Fire Protection Specialist when submitted to the Government.

### 3.2 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, and publications referenced therein.

### 3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system is being provided and installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final

tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance with the contract requirements. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

### 3.4 ABOVEGROUND PIPING INSTALLATION

#### 3.4.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection shall include flexible and rigid couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required by NFPA 13 for protection of piping against damage from earthquakes.

#### 3.4.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

#### 3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

#### 3.4.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 12 inches. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling shall not extend more than 1 inch below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 4 inches. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

##### 3.4.4.1 Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid.

#### 3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

#### 3.4.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site.

Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools shall be products of the same manufacturer. For copper tubing, pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.4.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

#### 3.4.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 07840A FIRESTOPPING.

In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

#### 3.4.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

#### 3.4.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to the remote branch line; a test valve located approximately 7

feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

#### 3.4.11 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 3 gallons, the auxiliary drain shall consist of a valve not smaller than 1/2 inch and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 3 gallons, the auxiliary drain shall consist of two 1 inch valves and one 2 x 12 inch condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 1 inch in diameter. Tie-in drain lines shall be pitched a minimum of 1/2 inch per 10 feet.

#### 3.4.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

#### 3.4.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

### 3.5 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 3 feet. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 6 inches above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls shall meet the requirements of Section 02510A WATER DISTRIBUTION SYSTEM.

### 3.6 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02315A EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

### 3.7 ELECTRICAL WORK

Except as modified herein, electric equipment and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Alarm signal wiring connected to the building fire alarm control system shall be in accordance with 16175 ANALOG ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM. Wiring color code shall remain uniform throughout the system.

### 3.8 DISINFECTION

After all system components are installed and hydrostatic test(s) are successfully completed, each portion of the sprinkler system to be disinfected shall be thoroughly flushed with potable water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. Flushing shall be conducted by removing the flushing fitting of the cross mains and of the grid branch lines, and then back-flushing through the sprinkler main drains. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump shall be used. Chlorination application shall continue until the entire system is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained. After successful completion, verify installation of all sprinklers and plugs and pressure test the system.

### 3.9 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 3.10 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

#### 3.10.1 Underground Piping

##### 3.10.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

#### 3.10.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints, regardless of pipe diameter.

#### 3.10.2 Aboveground Piping

##### 3.10.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

##### 3.10.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor shall provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, and pitot tube gauge. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. A metal placard shall be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate. The pressure drop shall be compared to the manufacturer's data.

#### 3.10.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

#### 3.10.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

### 3.11 FINAL ACCEPTANCE TEST

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test and shall provide a complete demonstration of the operation

of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received.

### 3.12 ON-SITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the Preliminary Tests and Final Acceptance Test. The On-Site Training shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

## SECTION 14240A

ELEVATORS, HYDRAULIC  
08/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1999e1) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 176	(1999) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 366/A 366M	(1997e1) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 568/A 568M	(1998e1) Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
ASTM A 569/A 569M	(1998) Commercial Steel (CS) Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled
ASTM D 92	(1998a) Flash and Fire Points by Cleveland Open Cup (IP36/84(89))
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials

## ASME INTERNATIONAL (ASME)

ASME A17.1	(1998a) Safety Code for Elevators and Escalators
ASME A17.2.2	(1998) Inspectors' Manual for Hydraulic Elevators
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1998) Power Piping
ASME QEI-1	(1997) Standard for the Qualification of Elevator Inspectors

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191 Americans with Disabilities Act (ADA)  
Accessibility Guidelines for Buildings and  
Facilities

## U.S. ARMY CORPS OF ENGINEERS (USACE)

TI 809-04 (1998) Seismic Design for Buildings

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 795 (Basic) Uniform Federal Accessibility  
Standards

## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO Building Code (1997) Uniform Building Code (3 Vol.)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3 (1995) High-Pressure Decorative Laminates

NEMA MG 1 (1998) Motors and Generators

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 252 (1999) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

## Elevator System; G

Detail drawings including dimensioned layouts in plan and elevation showing the arrangement of elevator equipment, anchorage of equipment, clearances for maintenance and operation; and details on hoistway, doors and frames, operation and signal stations, controllers, motors, guide rails and brackets, cylinder and plunge unit, and points of interface with normal power fire alarm system and interface with emergency power systems. Drawings shall show any revised building electrical system required to make supplied elevator system function as specified. Drawings shall contain complete wiring diagrams showing electrical connections and other details required to demonstrate sequence of operation and functions of system devices. Drawings shall include the appropriate sizing of electrical protective devices which are frequently different from National Electrical Code standard sizes.

## SD-03 Product Data

#### Training Data; G

Information describing the training course for operating personnel, training aids and samples of materials to be used, training schedules, and notification of training.

#### Elevator System

A complete list of equipment and material, including illustrations, schedules, manufacturer's descriptive data and technical literature, performance charts, catalog cuts, installation instructions, brochures, diagrams, and other information required for fabrication and installation of the equipment. Data shall include calculations for reaction loads imposed on building by elevator systems and to demonstrate that the proposed elevator system conforms to paragraph SEISMIC REQUIREMENTS. Certified copies of list reports may be submitted in lieu of calculations. Calculations to demonstrate compliance with ASME A17.1, Rule XXIV shall be included. Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than 8 weeks prior to date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended to be replaced and replacement interval required. Data shall include appropriate sizing of electrical protective devices.

#### Framed Instructions

Diagrams, instructions, and other sheets proposed for posting.

#### Test Procedures; G

A plan detailing the testing procedures shall be submitted 60 days prior to performing the elevator tests.

#### SD-04 Samples

##### Finishes

Samples of materials and products requiring color or finish selection.

#### SD-06 Test Reports

##### Testing; G

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of installed system.

#### SD-07 Certificates

##### Qualification Certificates

Certificates of experience of elevator mechanics employed to install, supervise and test the elevator shall certify mechanics to

have not less than 5 years experience installing, supervising and testing elevators of the type and rating specified. Certificate shall certify that elevator system installer is acceptable to elevator manufacturer prior to installation of elevators.

#### SD-10 Operation and Maintenance Data

##### Elevator System: G

Six copies of operation manual outlining the step-by-step procedures for system startup, operation and shutdown. Manuals shall include manufacturer's name, model number, service manual, parts list and brief description of all equipment, including basic operating features. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Manuals shall include equipment layout and complete wiring and control diagrams of the system as installed. Operation and maintenance manuals shall be approved prior to training course.

### 1.3 QUALIFICATIONS

Hydraulic elevators shall be pre-engineered elevator systems, and provided by a company regularly engaged in the manufacture of elevator systems. The manufacturer shall either install the elevator system or provide letter of endorsement certifying that the elevator-system installer is acceptable to the manufacturer.

### 1.4 REGULATORY REQUIREMENTS

Design and fabrication shall be in accordance with ASME A17.1. Each car shall have the capacity to lift a live load, exclusive of the car, at a speed as specified in the following schedule. The approximate travel, terminal floors, number of stops and openings, and the car sizes shall be as shown in the schedule. The elevators shall serve the floors with stops and openings in accordance with the requirements indicated. Elevators shall provide accessibility and usability for physically handicapped in accordance with the requirements for the handicapped in FED-STD 795 and 36 CFR 1191.

#### 1.4.1 Elevator Schedule (Passenger)

Number of Elevators Required:	1
Service:	Passenger
Capacity:	2100 pounds
Speed:	125 fpm (full load up) (150 fpm downspeed)
Platform Size:	6 feet - 0-3/4 inches wide by 5 feet - 0 - 1/4 inches deep
Clear Car Inside:	5 feet - 8 inches wide by 4 feet - 3 inches deep
Net Travel:	32 feet

Landings:	3
Openings: Front	3
Entrance Type:	Horizontal-sliding Single-speed

#### 1.4.2 Elevator Schedule (Freight)

Number of Elevators Required:	1
Loading Classification: Class A	ASME A17.1,
Capacity (Based on Platform Size @ 50 lbs/sq.ft.):	4000/6000 pounds
Speed:	80 fpm (full load up)
Platform Size:	Based on Hoistway Size = HW less 2 feet - 0 inches for Power Doors wide by Based on Hoistway Size = HW - 10 inches for Vertical BP Doors deep
Net Travel:	32 feet
Landings:	3
Type of Doors:	Power
Door Size:	Platform Width less 4 inches wide by Clear Car Height High
Openings: Front	3

#### 1.5 DESIGNATED LANDING

For the purposes of firefighter's service and emergency operations, as required by Section 211, ASME A17.1, the designated landing or level shall be the first floor. The alternate landing or level shall be the second floor.

#### 1.6 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variations; and dirt, or other contaminants.

#### 1.7 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing any work.

#### 1.8 WARRANTY

Warranty service shall be provided for each elevator for a period of 12 months after date of acceptance by Contracting Officer. Warranty service shall be performed only by trained elevator mechanics during regular working hours and shall include manufacturer's warranty requirements including but not limited to adjusting, lubricating and cleaning of equipment and furnishing supplies and parts to keep elevator in operation, except such parts made necessary by misuse, accident or negligence not caused by the Contractor. Testing and adjustments shall be in accordance with the applicable provisions of ASME A17.1 and ASME A17.2.2. Emergency callback service shall be included and available 24 hours a day, 7 days per week, with an initial telephone response time of 1 hour and a response time of 4 hours for a mechanic to the site. Inspection and service for fire service operation seismic requirements shall be performed every 6 months. Documentation of inspection and testing, and certification of successful operation shall be provided with each unit.

## PART 2 PRODUCTS

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard Products

Material and equipment shall be the standard products of manufacturers regularly engaged in the fabrication of elevators and/or elevator parts, and shall essentially duplicate items which have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is available 24 hours a day, 7 days per week, with a response time of 4 hours.

#### 2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, and electrical and mechanical characteristics on a plate secured to the item of equipment.

#### 2.1.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

#### 2.1.4 Electrical Work

Changes to the electrical distribution system required for coordination with elevator equipment shall be performed and coordinated by Contractor, at Contractor's expense. Electrical service for elevator machines shall be 480 volt, 60-Hertz, 3-phase, 4 wire solid neutral grounded alternating current. Electric service for elevator car lighting shall be 120-volt, single-phase, 60-Hertz grounded service. Electrical work shall conform to requirements in Section 16415 ELECTRICAL WORK, INTERIOR. A disconnect switch that will shut off power to the elevator car lighting shall be provided in the elevator machine room adjacent to the elevator control panel. A telephone junction box and an elevator car lighting junction box shall be provided adjacent to each controller. A single-phase electric circuit with grounded connection for video monitor shall be provided in machine room.

#### 2.1.5 Use of Asbestos Products

Materials and products required for manufacturing and installing elevators shall not contain asbestos.

## 2.2 MISCELLANEOUS MATERIALS

### 2.2.1 Materials for Car Enclosures

Materials for car enclosures shall meet flame spread rating 0 to 75 and smoke development 0 to 450 as tested in accordance with requirements of ASTM E 84 as established by ASME A17.1, Rule 204.2.

### 2.2.2 Structural Steel

Structural steel shall be hot-rolled commercial quality carbon steel, pickled, oiled, complying with ASTM A 569/A 569M and ASTM A 568/A 568M.

### 2.2.3 Cold-Rolled Sheet Steel

Sheet steel shall be cold-rolled commercial quality low carbon steel, Class 1, exposed matte finish, oiled, complying with ASTM A 366/A 366M and ASTM A 568/A 568M.

### 2.2.4 Stainless Steel

Stainless steel shall be ASTM A 176 Type 302/304, austenitic, corrosion-resistant, with grain of belting in the direction of longest dimension. Surfaces shall be smooth and without waves and shall be in compliance with ASTM A 366/A 366M.

## 2.3 PASSENGER ELEVATOR CAR

### 2.3.1 Car Fronts

Fronts for passenger elevators shall be combination door post and return panels manufactured of 14 gauge stainless steel provided with necessary cutouts for operating devices. Car operating panel shall be recessed into front return panel with surface-applied operating panel cover. Position indicator in front return shall be recessed with a surface-applied cover plate. Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified.

### 2.3.2 Car Doors

Car doors for passenger elevators shall be constructed from 16 gauge sheet steel and stainless steel cladding. Each door shall be sound-deadened and reinforced to receive required operating mechanism and hardware, and have two removable door guides per panel. Seams, screws or binding strips shall not be visible from within the car. Threshold shall be extruded aluminum with grooves for door guides. Exposed stainless steel shall be finished with No. 4 Satin Finish, unless otherwise specified. Car doors shall be equipped with a proximity-type infrared protective device having the following operation:

- a. When doors are in full-open position, doors shall be unable to initiate closing if a person comes within detection zone. Detection zone moves with doors, so that if a passenger or object enters the zone after doors have begun to close, doors shall stop, then reverse to reopen. Doors shall reclose after a brief time. A passenger entering or leaving cars shall not cause doors to reopen

unless doors reach a predetermined proximity to passenger.

- b. After a stop is made, doors shall remain open for a time to permit passenger transfer, after which doors shall close automatically. This time interval shall be less for a car call than for a hall call or a coincident car/hall call.
- c. If there is either a hall call anywhere in the group or a car call in the car in question and doors are prevented from closing for a fixed time period, door protective device shall be rendered inoperative, a buzzer shall sound in car and doors shall close at approximately half speed. Normal door operation shall resume at next landing reached by car.

### 2.3.3 Car Platform

Car platform for passenger elevators shall be fabricated from steel plates secured to a steel frame or plywood secured to a steel frame. Steel car platforms shall be assembled into a one-piece platform with top and bottom steel plates welded to structural steel frame and covered with felt and sound-isolation. Plywood car platform shall be 3/4 inch thick Exposure 1 plywood secured to underside of structural steel frame with metal fire protection secured to underside of structural steel frame.

### 2.3.4 Sling

Sling for passenger elevators shall be constructed of heavy steel stiles properly affixed to a steel crosshead and bolster with adequate bracing members to remove all strain from car enclosure. Steel bumpers shall be furnished for fastening sling to plunger.

### 2.3.5 Walls

Walls for passenger elevators shall be 7 feet 11-1/2 inches high from floor to the underside of lighting fixtures. Side and rear panels shall be 16 gauge sheet steel panels. Side and rear removable panels shall be applied to car walls and shall be manufactured from 3/4 inch plywood or composition board finished on front, back and edges faced with plastic laminate conforming to NEMA LD 3, general purpose type. Panels shall be evenly spaced with not less than two panels on each side and three panels at rear with reveal standard with manufacturer. Vent around base shall be provided.

### 2.3.6 Car Top, Ceiling and Light Fixtures

Car top for passenger elevators shall be manufactured from 12 gauge sheet steel and shall be not less than 5-1/2 inches high with drop-ceiling and light fixtures. Ceiling shall be 1/8 inch thick translucent white plastic fire-retardant light diffuser supported by baked-enamel perimeter frame and dividers to form drop-ceiling light fixture. Light fixtures shall be fluorescent type flush with car ceiling, manufactured of sheet steel with flange and enclosed sides and top, baked-enamel reflector, mounted directly to outlet box. Bottom of fixtures shall be flush with car ceiling. Fluorescent light fixtures shall be dual lamp with quick-starting high-power factor, Class P ballasts with safety lamp guard clamps on fluorescent tubes. Light level shall average at least 10 footcandles measured at the car threshold, with the door closed. A part of car light fixture shall be removable to permit use of the emergency exit panel in top of car.

### 2.3.7 Emergency Exit

Car top for passenger elevators shall be manufactured with a hinged emergency exit panel of 12 gauge steel which opens up to clear the crosshead and car door operator. Emergency exit panel shall be hinged on counterweight side and held in place with nonremovable fastening devices at each corner, and be openable from top of car only. A minimum of two sides of exit panel shall lap exit opening by 1 inch. Exits shall be equipped with electrical contacts which will prevent operation of car when the exit door is open and cause the alarm bell to ring.

### 2.3.8 Floor Finish

Floor finish for passenger elevators shall be finished with resilient tile flooring not less than 3/16 inch thick or flexible type homogeneous vinyl tile not less than 1/8 inch thick as specified in Section 09650 RESILIENT FLOORING. Tile shall be laid flush with the extruded aluminum platform threshold.

### 2.3.9 Base

Base for passenger elevators shall be 6 inches high.

### 2.3.10 Handrails

Handrails for passenger elevators shall be mounted on each wall and shall comply with ASME A17.1, FED-STD 795 and 36 CFR 1191. For elevators with two-speed horizontal-slide openings, handrails shall be turned back to wall.

### 2.3.11 Exhaust Fan

Exhaust fan for passenger elevators shall be two-speed exhaust type ventilating unit mounted in car ceiling and shall be provided with a grille. Units shall be suitably isolated from car ceiling and shall provide at top speed of a minimum of 6 air changes per hour for car volume and car occupancy. Switches for the operation of the exhaust unit shall be located in car station locked cabinet or key-switched.

### 2.3.12 Communications

A telephone system in stainless steel cabinets shall be provided for passenger elevators. A vandal-resistant speaker type intercom with push-buttons to activate shall be installed in car station behind a stainless steel perforated grille and connected to a programmable auto-dialer located in machine room. Auto-dialer shall be provided with a solid-state charger unit which will automatically provide emergency power and an immediate transfer in the event of failure of normal power supply. The push-button located in car station or in separate cabinet shall be at the prescribed handicapped height and shall be identified as "EMERGENCY PHONE PUSH TO ACTIVATE". The entire communication assembly shall be approved for an elevator installation. The push button telephone shall comply with FED-STD 795 and 36 CFR 1191. The telephone communication shall not be terminated until one of the communicating parties hangs up the receiver or manually disconnects the communication link.

### 2.3.13 Car Emergency Lighting System

Emergency car lighting system for passenger elevators shall consist of an

emergency power pack on top of the elevator and a remote lighting fixture inside elevator car located in car operating panel.

#### 2.3.13.1 Power Pack

Power pack for emergency lighting system shall be a sealed lead-cadmium or nickel-cadmium 6-volt rechargeable batteries with solid-state controls and an integral regulating charger connected to normal power supply. Power pack unit shall contain the following:

- a. Minimum 6 inch diameter alarm bell connected to the elevator alarm and emergency push-button.
- b. Top of car light fixture with protective wire guard.
- c. Testing circuit and pilot light.
- d. Low-wattage pilot light indicator.
- e. Battery low-voltage disconnect.

#### 2.3.13.2 Emergency Light Fixture

Emergency light fixture shall be located in car station inside elevator car, with flush-mounted lens and shall consist of the following:

- a. A minimum of two lamps capable of providing a minimum level of illumination of 1.0 footcandle at a point 4 feet above the floor, 1 foot in front of car station.
- b. Frosted acrylic lens.

#### 2.3.13.3 Remote Light Fixture

Upon interruption of normal power, remote light fixture for passenger elevators shall automatically and immediately illuminate and permit operation of alarm bell, subject to activation of emergency stop-switch or alarm button. Emergency power pack shall be capable of providing a minimum of 1 hour emergency bell operation and 4 hours of continuous illumination.

#### 2.3.14 Certificate Frame

A stainless steel certificate frame with translucent plexiglass lens of the appropriate size to receive certificate issued by inspecting agency shall be provided. Frame shall be engraved to show name of manufacturer, carrying capacity in pounds and maximum number of persons allowed.

#### 2.3.15 Car Guide Shoes

Guide shoes for passenger elevators shall be the adjustable mounting type on each side of car. Shoes shall be rigidly secured in accurate alignment at top and bottom of car frame. Flexible type sliding guide shoes shall consist of a swivel-type shoe, assembled on a metal base with provisions for self-alignment. Each shoe shall be provided with renewable gibs. Car guide shoes shall be adjustable for side play between guide rails. Renewable wearing gibs shall be fabricated from a durable plastic compound material having a low coefficient of friction and long wearing qualities. Gibs shall be the type requiring minimum rail lubrication.

## 2.4 PASSENGER ELEVATOR HOISTWAY ENTRANCES

### 2.4.1 Hoistway Doors

Hoistway doors for passenger elevators shall be designed and fabricated as part of a Class B 1-1/2 Hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Doors for passenger elevators shall be hollow metal type with plain panel design not less than 1-1/4 inches thick with 16 gauge face sheet-steel panels, and stainless steel cladding, with 16 gauge sight guards to match door finish. Each door shall be reinforced with continuous vertical members and filled with sound-deadening material. Doors shall be reinforced to accept the required operating mechanism and hardware. Doors shall have two removable door guides per panel. Seams, binding strips or screws shall not be visible from the landing. Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified.

### 2.4.2 Hoistway Frames

Hoistway frames for passenger elevators shall be designed and fabricated as part of a Class B 1-1/2 Hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Frames shall be formed 14 gauge sheet-steel with head and jamb in flush alignment and corners welded and ground smooth. Head and jamb section shall be bolted assembly with bolts, washer and locking nut or lock washer. Frame assembly shall be securely fastened to the structure. Frames shall return to the wall. Combination buck and jamb frames may be provided with knockdown back flanges to permit installation in concrete walls. Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified.

### 2.4.3 Symbols

Raised stainless steel symbols as required by FED-STD 795 and 36 CFR 1191 of color selected, shall be provided at each floor to indicate the floor location. Symbols shall be attached with concealed fasteners. Symbols shall be placed in a location which can be seen by passenger from the opened passenger elevator doors.

### 2.4.4 Sills

Sills for passenger elevators shall be extruded aluminum with slip-resistant surface and machined grooves for door guides, secured to floor beams.

### 2.4.5 Strut Angles

Strut angles for passenger elevators when required shall be structural steel of size not less than 3 x 3 x 3/16 inch extending from sill to beam above and anchored to building structure with structural steel fastenings and bracings of structural members with a cross section of not less than strut angles.

### 2.4.6 Door Hangers and Housing

Each door panel shall be provided with not less than two sheave-type hangers designed for required door operation. Hanger housing and support shall be fabricated from formed Z-shaped steel angles of size not less than

3/16 inch thick bolted to strut angles.

#### 2.4.7 Door Rollers

Door rollers shall be constructed with grease-packed ball-bearings and shall be tired with a sound-reducing material. Diameter of rollers shall not be less than 3-1/4 inches for car doors and not less than 2-1/4 inches for hoistway doors. Upward thrust shall be taken by a hardened and ground ball-bearing roller assembled on an eccentric stud to provide adjustment.

#### 2.4.8 Hanger Track

Hanger track shall be of high carbon cold-drawn steel, round at top to receive door rollers, round at bottom to receive up-thrust rollers, of size engineered to accommodate load requirements.

#### 2.4.9 Covers and Guards

Hanger covers, dust covers, toe guards and fascia plate shall be fabricated from 16 gauge reinforced steel and finished with baked-enamel. Hanger covers shall extend the full door travel and shall be mounted in sections for ease of servicing door hangers. Dust covers shall be provided over top terminal landing door only and shall be secured to hanger housing and building structure. Toe guards shall be secured to sill. Fascia plates shall be provided between each door hanger housing and sill.

### 2.5 PASSENGER ELEVATOR DOOR OPERATION

Car and hoistway doors for passenger elevators shall be operated simultaneously by an electric-power door operator. Doors shall operate smoothly in the opening direction and closing direction and be electrically or hydraulically cushioned to stop at both the full-open and full-closed position. Operators shall be high-speed heavy-duty type which will provide an average door-opening speed of 2-1/2 fps. Car and hoistway doors shall be opened and closed simultaneously. When on automatic operation door-closing force shall not exceed 30 pounds. Reversal of doors when closing shall be accomplished by the "DOOR OPEN" button, car door safety edge, or interruption of the photoelectric light beams. Doors shall be arranged so that doors can be opened manually in the event of power failure.

### 2.6 PASSENGER ELEVATOR OPERATING AND SIGNAL FIXTURES

#### 2.6.1 General

Elevator fixtures and panels for passenger elevators shall be constructed of stainless steel. Fastenings for all exposed fixtures shall be secured with tamper-proof spanner-head screws of same material and finish as fixture. Hall and car call-buttons shall be the call-register type with a low-voltage power supply not to exceed 48 volts. Pressure on a button shall illuminate button to indicate that a call in the desired direction has been registered. Car and hall fixtures shall be designed and located at the prescribed height to accommodate the handicapped in accordance with FED-STD 795 and 36 CFR 1191 for passenger elevators only. Handicapped markings shall be integral with faceplates in accordance with FED-STD 795 and 36 CFR 1191. Surface-applied markings are not acceptable. Engraving shall be black-filled except for fire-service identification which shall be red-filled. Operating and signal fixture contacts and lamps shall be completely enclosed in steel boxes finished with a baked-enamel. Boxes for hall landing devices shall be equipped for proper adjustment to wall.

Lamps shall be installed in light-tight compartments. Cover-plates shall be provided with rubber gaskets when exposed to weather or harmful contaminants. Replacement bulbs shall be readily available from three sources.

#### 2.6.2 Car Operating Panel

Car operating panel for passenger elevators shall be provided with the necessary raised ( 0.03 inch) markings for the handicapped. Operating buttons shall be of manufacturer's standard design. Operating buttons shall be vandal-resistant metal encased and embossed to permit illumination when a call is registered. Buttons shall be designed with 1/32 inch operating clearance to set on faceplate in lieu of the button mechanism. Buttons shall have maximum protrusion of 3/16 inch beyond the faceplate and shall have beveled edges to prevent damage from side blows. Buttons and switches not required for automatic or fire-service operation shall be key-operated and mounted on front-return car operating station. Elevator number and "NO SMOKING" shall be international symbol engraved on upper portion of car. Operating panel in car shall consist of a flush-mounted panel containing the following operating devices:

- a. "DOOR OPEN" button.
- b. "DOOR CLOSE" button.
- c. Key-operated car fan/light switch.
- d. Key-operated ventilating blower switch/call light.
- e. Communication speaker phone, grille and push-to-call button telephone.
- f. Emergency stop-switch key-operated behind locked cover when operated will stop the car independently of normal stopping devices. Operation of emergency stop switch shall not cause any power variance or surge that may affect the operation or condition of the control panel or its components.
- g. Emergency signal-switch connected to a 6 inch diameter signal bell outside of elevator hoistway at located as directed.
- h. Key-operated independent operation switch (for multi-car only).
- i. Key-operated inspection switch which will render normal operation inoperative for the purpose of using the hoistway access switch.
- j. Key-operated fire-service switch and light jewel.

#### 2.6.3 Hall-Call Station

Hall-call operating devices for passenger elevators at landing shall consist of an "UP" push-button at bottom landing, a "DOWN" push-button at top landing, and "UP" and "DOWN" push-buttons at all other landings. Buttons shall be vandal-resistant metal encased and back-lighted to permit illumination when a call is registered. Buttons shall be designed with 1/32 inch operating clearance to seat on faceplate in lieu of button mechanism. Buttons shall have maximum protrusion of 3/16 inch beyond faceplate with beveled edges to prevent damage from side blows.

#### 2.6.3.1 Fire-Service Switch

Fire-service switch for passenger elevators shall be located at the designated landing.

#### 2.6.4 Direction Lanterns

Lanterns for passenger elevators shall be in accordance with FED-STD 795 and 36 CFR 1191 and shall be provided at all floor landings. Lanterns shall be vandal-resistant design. Lanterns shall signal the approach of a stopping car when car is a predetermined distance from landing.

#### 2.6.5 In-Car Car-Position Indicator

Indicator numerals and directional arrows for passenger elevators shall be vandal-resistant. As car travels through hoistway the car position shall be indicated by illumination of light jewel corresponding to landing at which the car is stopped or passing. Necessary light baffles shall be provided. Floor numerals and letters shall illuminate white. A position indicator of the digital-readout or dot-matrix type (minimum 2 inch high indication) shall be provided in car transom panel. Number corresponding to car position shall remain illuminated when motor drive is shut down. Illumination shall be shrouded in an approved manner to protect against glare from car lighting.

#### 2.6.6 Audible Signals

An audible signal shall be provided at each floor landing and shall sound coincident with the landing lantern illumination indicator. The audible signal shall be no less than 20 decibels with a frequency no higher than 1500 Hz. The audible signal shall sound once for UP direction and twice for DOWN direction.

### 2.7 PASSENGER CAR OPERATION (SINGLE-CAR SELECTIVE/COLLECTIVE)

Passenger Elevator No. 1: Car shall be arranged so that by pressing one or more car buttons or landing buttons the car will start automatically and stop at floor for which the button has been pressed which corresponds to the direction in which the car is traveling. Car shall stop in the order in which the floors are reached by the car and at all floors for which calls have been registered, regardless of the sequence in which buttons have been pressed, provided button for a given floor has been pressed sufficiently in advance of car's arrival at that floor to permit the stop to be made. If car buttons have not been pressed, and car responds to several DOWN calls, car shall travel to highest DOWN call first and then reverse to collect UP calls. UP calls shall be collected in the same way when car starts DOWN in response to UP calls by first stopping for the lowest UP call registered. When a car has stopped in response to the pressing of a landing button and a car button is pressed corresponding to the direction in which the car has been traveling, within a predetermined interval of time after the stop, the car shall continue in that direction regardless of other landing calls registered. While car is in motion landing calls in the opposite direction of car movement shall not affect the operation of car but calls shall remain registered. After last car call has been answered in the direction the car is traveling, car shall automatically reverse and answer registered landing calls and all car calls in the order the landings are reached. When all calls have been answered, the car shall stop at the last floor served and shall have the doors closed.

## 2.8 FREIGHT ELEVATOR CAR

Freight elevator car shall have plain steel panel sides to top of car, fabricated of not less than 12 gauge steel. Panels shall be not more than 36 inches wide of 1/4 inch thick steel plate from floor to 4 feet above floor and not less than 14 gauge steel panels from top of 1/4 inch plate to top of car. Top of car shall be not less than 14 gauge steel panels with a removable panel for emergency exit. Exit in top of car shall have an electric contact which will prevent operation of elevator when exit is in the open position. Top exit shall be provided with a latch-type lock operable from outside elevator car and operable with a specially designed tool from within the car.

### 2.8.1 Car Platform

Car platforms for freight elevators shall be of steel construction with a finish floor of raised pattern steel floor plate welded or bolted to platform framing members. Bolted platform shall be attached with countersunk flat-head bolts. A steel subfloor will not be required if the raised-pattern steel floor plate is of a thickness which will accommodate the capacity of elevator and required type of loading.

### 2.8.2 Sling

Sling for freight elevators shall be designed for the proper class loading and capacity, constructed of structural formed steel shapes welded or bolted together, consisting of double channel cross head and bolster with channel uprights, gusset plates and diagonal bracing.

### 2.8.3 Bumper Guards

Bumper guards for freight elevators shall be fabricated of 6 x 2 inch thick oak mounted on rear and sides of elevator car, beveled back to side walls at entrance columns. Bottom edges of bumper guards shall be 6 inches and 30 inches above floor.

### 2.8.4 Light Fixtures

Lighting fixtures for freight elevators shall be recessed, fluorescent type. Fixtures shall be manufactured of sheet steel with flange and enclosed sides and top shall have a baked-enamel reflector, and shall be mounted directly to outlet box. Bottom of fixture shall be flush with car ceiling. Fluorescent lighting fixtures shall be dual lamp with quick-starting high-power factor, Class P ballasts with safety lamp guard clamps on fluorescent tubes. Light level shall average at least 25 footcandles measured at car threshold with the doors closed.

### 2.8.5 Car Emergency Lighting Fixture

Power package as specified for passenger car emergency lighting shall be provided. Not less than two lamps of equal wattage shall be used to provide a minimum 10 footcandle of illumination at a point 4 feet above floor and 1 foot in front of main car operating device of emergency lighting for a period of at least 4 hours.

### 2.8.6 Communications

A telephone system in stainless steel cabinet shall be provided for freight elevators. A vandal-resistant speaker type phone with push-button to

activate shall be installed in car station behind a stainless steel perforated grille and connected to a programmable auto-dialer located in machine room. Auto-dialer shall be provided with a solid-state charger unit which will automatically provide emergency power with an immediate transfer in the event of failure of the normal power supply. The push-button located in car station shall be identified as "EMERGENCY PHONE PUSH-TO-ACTIVATE". The entire communication assembly shall be approved for an elevator installation. The telephone communication shall not be terminated until one of the communicating parties hangs up the receiver or manually disconnects the communications link.

#### 2.8.7 Freight Signs

Identification signs for freight elevators shall be fabricated of stainless steel and engraved to show the elevator capacity, class of loading and passenger limitations in the format required by ASME A17.1.

#### 2.8.8 Certificate Frame

A stainless steel certificate frame with translucent plexiglass lens shall be provided in the size required to receive the certificate issued by the inspecting agency. Frame shall be engraved to show name of elevator manufacturer and carrying capacity in pounds.

#### 2.8.9 Car Guide Shoes

Guide shoes for freight elevators shall be solid cast-iron or welded-steel type accurately machined and provided with approved replaceable liners and positive feed lubricators on car sling. Car guide shoes shall be standard heavy-duty freight elevator type mounted in mechanically equalized pairs on each side of car sling at top and bottom only as needed for shoe load. Mounting shall be arranged to keep car running smoothly and quietly on guide rails.

#### 2.8.10 Car Guide Rails

Guide rails for freight elevators shall be planed steel tee or omega shaped sections with structural channel rail backing as required and tongue-and-groove matched joints reinforced with fitted splice plates. Guide rails shall extend from bottom of pit to underside of roof over the hoistway.

### 2.9 FREIGHT ELEVATOR ENTRANCES

#### 2.9.1 Hoistway Frames

Hoistway frames for freight elevators shall be designed and fabricated of structural members and installed by steel erector subcontractor as part of a Class B 1-1/2-hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected unless otherwise specified.

#### 2.9.2 Hoistway Doors

Hoistway doors for freight elevators shall be designed and fabricated as part of a Class B 1-1/2 Hour fire-rated door/frame assembly to meet requirements of NFPA 252 and shall bear the label of an approved testing laboratory. Door panels shall be vertical bi-parting counterbalanced,

power operated which shall consist of 2 sections designed to balance each other and to move simultaneously. Door panel construction shall be 12 gauge sheet steel with formed edges and vertical reinforcing back ribs spaced 18 inches on center. Each door shall be reinforced on the periphery with a frame of built-up steel angles or other suitable sections not less than 3/16 inch thick for mounting the necessary guide shoes and chain-suspension system. Door panels shall be securely bolted into the door panel frames. Exposed steel shall be finished with rust-inhibitive primer and baked-enamel in a color to be selected, unless otherwise specified.

#### 2.9.2.1 Upper Door Panel

Upper panel of each freight elevator hoistway door shall be equipped with a clear wire glass vision panel placed on the side closer to car operating station. Vision panel shall be sized as required by ASME A17.1. Bottom edge of panel shall be provided with a fire-resistant approved safety astragal which shall be nonshearing and noncrushing and will not damage foreign objects 3/4 inch or less when door is in the closed position. Rubber bumpers shall be provided on lower edge of panel near each jamb mounted to provide the safety action specified. Rubber bumpers and safety astragals shall be designed for easy replacement.

#### 2.9.2.2 Lower Door Panel

Lower panel for each freight elevator hoistway door shall be provided with a 1/2 inch thick steel toe guard beveled toward hoistway wall to a 60-degree angle to horizontal. Upper edge of lower panel shall be equipped with a truckable steel sill designed to be level with landing when doors are in the fully-open position. Truckable sills shall be of sufficient size and adequate strength to bridge the space between building sill and car platform and to support a trucking load equal to rated capacity of elevator car. Truckable sill shall extend the full width of door opening and shall be supported by stationary adjustable stops fastened to each door guide rail. Shearing hazard shall not exist on bottom door panel during the door opening operation.

#### 2.9.2.3 Door Guide Rails

Guide rails for freight elevator hoistway doors shall consist of suitable structural shapes for each door section securely fastened to door frame and hoistway construction. Guide rails shall be designed and fabricated in accurate alignment so that door guide shoes will operate freely upon rails.

Each door frame shall be equipped with four fixed or adjustable steel or malleable-iron grooved shoes of proper depth and vertical side contact on each side of rail. Shoes shall be attached to vertical structural door frame members and shall be spaced the maximum possible distance apart. Shoes shall be constructed to relieve door and guide shoe supporting members of all frictional contact with guide rails.

#### 2.9.2.4 Door Interlocks

Hoistway doors for freight elevators shall be equipped with a tamper-proof interlock which shall prevent operation of car until doors are locked in the closed position as defined by ASME A17.1. Interlocks shall lock the two-door sections together to prevent doors from opening at corridor side unless car is at rest at landing or is traveling through leveling zone or the hoistway access switch is used. Retiring cams for hoistway door interlocks shall be provided and securely fastened to supports on car enclosure.

### 2.9.2.5 Door Unlocking Devices

Hoistway doors for freight elevators shall be equipped with unlocking devices as described in ASME A17.1 and shall be provided at all floors. Parking device shall be located at a floor selected by Contracting Officer.

### 2.9.3 Car Gates

Car gates shall be provided at each freight elevator entrance to protect entire width of opening to a height of 6 feet above sill. Car gates shall be heavy-duty vertical-sliding type constructed of minimum 10-gauge wire mesh or flat-expanded metal attached to steel angle frame with hardware and accessories as required. Car gates shall be equipped with weights for closing or balancing the gates. The guide shoes shall be designed to run on vertical tracks rigidly fastened to car enclosure. When fully raised the bottom edge of gates shall not protrude into clear opening of hoistway entrance. Lower edge of gate panel shall be equipped with a safety edge to stop the downward motion of gate when an obstruction is encountered. Car gates shall be pass-type 2-speed power-operated if there is insufficient clearance available when the elevator is at the top floor. Pass-type car gates shall be provided in conjunction with pass-type hoistway doors.

## 2.10 FREIGHT ELEVATOR DOOR AND CAR GATE OPERATION

Each hoistway door and car gate for freight elevators shall be equipped with an individual electric operator. Operators shall open and close car gate and hoistway doors at a panel speed of not less than 1 foot per second without slamming. Limit switches shall be provided to stop the motors as doors approach their limit of travel. Provisions shall be made for manual operation of the doors from inside the car in the event of power failure. Door operators shall be arranged to open doors automatically after the car enters the automatic leveling zone at the designated landing. "Open" and "close" operating buttons and any additional devices required shall be provided in car and at each hoistway entrance. Constant pressure on the "close button" shall close the door. Momentary pressure on the "open button" shall reopen the door provided the car is at a landing. Electric operators shall be of the highest quality and quiet in operation and shall be provided with all parts designed and constructed to meet the severe requirements of electrical service. Gates shall be provided with reversing edge and passenger sequence operation. Car doors shall be equipped with an infrared proximity-type protective device having the following operation:

- a. When doors are in full-open position doors shall be unable to initiate closing if a passenger comes within the detection zone. The detection zone moves with doors, so that if a passenger or object enters the zone after doors have begun to close, doors shall stop and then reverse to reopen. Doors shall reclose after a brief time. A passenger entering or leaving car shall not cause doors to reopen unless doors reach a predetermined proximity to passenger.
- b. After a stop is made, doors shall remain open for a time to permit passenger transfer after which the doors shall close automatically. The time interval shall be less for a car call than for a hall call or a coincident car/hall call.
- c. If there is either a hall call anywhere in the group or a car call in the car in question and doors are prevented from closing for a fixed time period, door protective device shall be rendered

inoperative, a buzzer shall sound in the car and the doors shall close at approximately half speed. Normal door operation shall resume at the next landing reached by car.

## 2.11 FREIGHT ELEVATOR OPERATING AND SIGNAL FIXTURES

Operating and signal fixtures for freight elevators shall conform to general requirements for passenger elevator operating and signal fixtures, with exception that compliance with FED-STD 795 and 36 CFR 1191 is not required.

### 2.11.1 Car Operating Panel

Operating panel in freight elevators shall consist of a recess-mounted panel near car gate containing the following operating devices:

- a. Emergency stop switch key-operated, when operated, will stop the car independently of the normal operating devices and sounds the emergency signal bell.
- b. Emergency signal button connected to a 6 inch diameter signal.
- c. Communication speaker phone, grille and push-to-talk button.
- d. Key-operated fire-service switch and light jewel.
- e. Momentary pressure "DOOR CLOSE" button and momentary pressure "DOOR OPEN" button for power-operated doors.

### 2.11.2 In-Car Position Indicator

In-car position indicator in freight elevators shall be vandal-resistant. As car travels through hoistway the car position shall be indicated by illumination of light jewel corresponding to landing at which the car is stopped or passing. Necessary light baffles shall be provided.

### 2.11.3 Car Push-Buttons

Car push-buttons in freight elevators shall be numbered to correspond to landings served. Faceplates shall be provided with raised indicators to the right of floor buttons. Buttons shall be encased with metal and embossed to permit illumination when a call is registered. Buttons for car and hall operating stations shall be designed to seat on faceplate in lieu of button mechanism with 1/32 inch operating clearance. Buttons shall have maximum protrusion of 3/16 inch beyond faceplate with beveled edges to prevent damage from side blows.

### 2.11.4 Hall-Call Station

Operating devices for freight elevators at each landing shall consist of a recess-mounted momentary pressure car call-button and momentary pressure "DOOR OPEN" button.

#### 2.11.4.1 Fire Recall Key

Fire recall key-switch for freight elevators shall be located at the designated landing faceplate.

#### 2.11.4.2 Hoistway Access Switches

Hoistway access switches for freight elevators shall be located in lower and upper terminal floor hall stations.

## 2.12 FREIGHT ELEVATOR OPERATION

### 2.12.1 General

When freight elevators are not in use and the door-locking circuit is established, the momentary pressing of a landing call-button shall bring the car to that landing. Momentary pressing of a car dispatching button in car panel shall send car to the designated landing if car gate and hoistway doors are closed and the door-locking circuit is established.

### 2.12.2 Car Operation

Freight elevators shall operate as an automatic simplex selective/collective as described for passenger elevator.

### 2.12.3 Service-Demand Bell

A service-demand bell shall be provided in freight elevator which will sound when a landing button is pressed while a door is in the open position.

### 2.12.4 Inspection and Maintenance Switch

An inspection and maintenance switch for freight elevator shall be mounted in car-control panel to disconnect the landing buttons. When the switch is closed the car may be operated by continuous-pressure on UP and DOWN buttons on top of car which will operate the car at a reduced speed.

## 2.13 AUTOMATIC EMERGENCY POWER OPERATION

Elevator control system shall be arranged to operate on emergency power supply upon failure of the normal power supply. Elevators operating on dedicated service, such as fire service, will not be required to return to designated landing when emergency power becomes available for respective elevator. Elevators shall operate as follows:

- a. When normal power supply fails, all cars shall shut down.
- b. Cars shall automatically start and travel at full-rated speed to designated landing, stop, open the car and hoistway doors, then shut down.
- c. After cars shut down, cars shall individually operate as described above except in case of fire service where fire service operation shall override..
- d. After all cars have moved to first floor and are not in fire service, cars shall operate at rated speed to serve car and landing calls. Automatic selection can be overridden manually.

## 2.14 AUTOMATIC ELEVATOR OPERATION

### 2.14.1 General

The operating device shall consist of a series of push-buttons in the car numbered to correspond to various landings, "UP" and "DOWN" buttons at

intermediate landings and a single button at terminal landing. To meet the elevator operation requirements specified in this section all buttons shall be connected electrically to the control system which governs the floor selection, car selection, direction of travel and governs the acceleration and retardation.

#### 2.14.2 Operation

Car calls shall be registered within the car by pressing the button corresponding to the designated floors. Hall calls shall be registered by pressing buttons in the corridor push-button fixture. Once the demand for elevator service has been established and the car has received a start signal the car operation shall be as follows.

##### 2.14.2.1 Door Closing

Doors shall close automatically. When doors are fully closed and the interlock circuit established, the car shall start to move in the direction established by control system. Car shall accelerate and decelerate automatically and stop at first floor for which a car button has been registered or at first floor for a corridor demand which has been assigned to car. Car shall stop at all floors for which car calls are registered in the order in which the floors are reached and shall stop for any corridor demands assigned to the cars in the order in which the floors are reached.

##### 2.14.2.2 Door Opening

Doors shall open automatically as car reaches the landing. After a predetermined time the doors shall close and the car shall proceed to answer the remaining car or assigned corridor calls. A protective device such as a safety edge and light beam device shall be provided on car door and when activated will prevent closing of doors. Cars shall become available for assignment at whatever floor the last car demand has been satisfied in the direction in which the car is traveling.

##### 2.14.2.3 Car Dispatch

When car does not receive a demand dispatch at dispatching floor for an adjustable time period up to 10 minutes set initially at 5 minutes, the motor drive unit shall be switched-off. If the car's switched-off motor drive unit receives a demand dispatch the motor drive unit shall automatically restart.

##### 2.14.2.4 Door Dwell-Time

Door open dwell-times shall be adjustable so that the open time for a car call is shorter than the open time for corridor calls and second passengers. If a longer time is needed for passenger entry, doors can be prevented from closing or reversing by the light beam door control, the protective leading edge on car door, or by pressing "DOOR OPEN" button in car. Door dwell-times shall comply with FED-STD 795 and 36 CFR 1191.

#### 2.15 COMMUNICATIONS LINKS OVER VOLTAGE PROTECTION

Communications equipment such as MODEMs, line drivers, and repeaters shall be protected against overvoltage on any communications link conductors. Cables and conductors, which serve as communications links, except fiber optics, shall have overvoltage protection for voltages up to 480 Vac rms, 60 Hz installed. Instrument fuses or fusible resistors are required for

this application.

## 2.16 FIREFIGHTERS SERVICE

Firefighter service shall be in accordance with ASME A17.1 for automatic elevators. Elevator lobby and machine room smoke detectors shall be photoelectric or ionization spot-type smoke detectors compatible with fire alarm system. Smoke detectors shall be powered from the building fire alarm control panel. Elevator lobby and machine room smoke detectors shall be in accordance with Section 16175 ANALOG ADDRESSABLE FIRE PROTECTION AND ALARM SYSTEM.

## 2.17 ELEVATOR POWER UNIT

### 2.17.1 Pumping and Control Mechanism

Hydraulic fluid shall be provided in the reservoir, pump and control valve.

Hydraulic fluid shall have a minimum fire point of 375 degrees F as established by ASTM D 92. If oil temperature drops below pre-set minimum, elevator shall be dispatched automatically to lowest terminal floor at which point the pump will bypass oil in system without car motion until pre-set temperature is reached. Normal response to passenger demand shall not be affected by this control. Resistance type heating elements do not meet the intent of this specification.

#### 2.17.1.1 Oil Temperature Device

An oil temperature device shall be provided that will maintain oil temperature between 70 degrees and 100 degrees F regardless of ambient temperatures.

#### 2.17.1.2 Pump

Pump shall be a rotary-positive displacement type for oil-hydraulic elevator service designed for steady discharge with minimum pulsation to give smooth and quiet operation, with an output which will not vary more than 10 percent between no-load and full-load on the elevator. Operating pressure shall not exceed 400 psi.

#### 2.17.1.3 Piping

Piping shall be ASTM A 53/A 53M Grade E or S, ASTM A 106 Grade B, or grooved piping system of minimum schedule 40 seamless steel conforming to ASME A17.1 and ASME B16.11. Pipes shall conform to the cleanliness requirements of ASME B31.1.

#### 2.17.1.4 Motor

Motor shall be especially designed for oil-hydraulic elevator service and shall be of standard manufacture duty rating and provided with specified speeds and loads.

#### 2.17.1.5 Oil-Control Unit

Oil-control unit shall contain the following valve assemblies:

- a. Automatic shut-off valve shall be provided in the oil-supply line as close to the cylinder inlet as possible. When there is a 10 percent drop in NO-LOAD operating pressure, the automatic shut-off

valve shall be activated. When activated, the device shall immediately stop the descent of elevator and hold the elevator until it is lowered by use of the maximum lowering feature of the valve. Manual lowering feature of automatic shut-off valve shall be arranged to limit the maximum descending speed of elevator to 15 feet per minute. Exposed adjustments of automatic shut-off shall have the means of adjustment sealed after being set to the correct position.

- b. Relief-valve for hydraulic shall be externally adjustable and shall bypass the total oil flow without increasing back pressure by more than 56 percent above working pressure.
- c. Safety check-valve shall close quietly without permitting any perceptible reverse flow and shall be designed to support the elevator on a positively locked column of oil when car is at rest.
- d. Up-start and stop valve shall be externally adjustable and shall bypass oil flow during the start-and-stop of motor-pump assembly. Valve shall close slowly, gradually diverting oil to the jack unit to insure smooth up-start and up-step.
- e. Lowering and leveling valve shall be externally adjustable for drop-away speed, lowering speed, leveling speed and stopping speed to insure smooth down-starts and stops. Leveling valve shall be designed to level the car to floor in the direction the car is traveling when slowdown is initiated.
- f. Manual lowering valve shall be capable of lowering the elevator car in event of power failure. Manual-lowering valve shall be arranged to limit the maximum descending speed under manual operation to 15 fpm.
- g. A service check-valve shall be installed in oil supply line between power unit and jack.

#### 2.17.1.6 Storage Tank

Storage tank shall be single-wall construction of steel with a steel cover. Manufacturer's recommendation for the type of oil to be used shall be included in written instructions for the care, adjustment and maintenance of equipment.

#### 2.17.1.7 Controller

Electric controller shall be of the microprocessor based logic type with battery backup provided with reduced voltage starting. Components required for proper elevator performance shall be neatly mounted and wired and completely enclosed in a cabinet with a mechanically-latched door. Control cabinet shall be designed for mounting on power unit, wall or floor stand. Electric control apparatus shall be completely isolated from oil reservoir.

A feature shall be incorporated in electrical control circuit which will cause elevator car to descent automatically to the lowest terminal landing, if the system runs low on oil during ascending of the car. If power-operated doors are used, the car and hoistway doors shall automatically open when car reaches landing to allow passengers to exit. Parked car shall have doors in closed position and all control buttons shall be made inoperative.

### 2.17.2 Sound Reduction

Sound-insulating panels shall isolate airborne noise from motor pump assembly. Openings shall be provided to adequately ventilate the power unit motor. A minimum of two sound-isolating couplings shall be installed in oil line in machine room between pump and jack. Couplings shall be designed and manufactured to be blowout proof. Oil-hydraulic silencer shall be installed in oil line near power unit and shall contain pulsation absorbing material surrounded by a blowout-proof housing. Power unit assembly shall be mounted on vibration pads to isolate the unit from building structure.

### 2.18 LEVELING DEVICE

Elevators shall be equipped with a 2-way leveling device to automatically bring the car to floor landings. Car shall automatically re-level at each landing to correct the overtravel and undertravel, and maintain the level regardless of load on car. Electric stopping system shall be arranged so that the car will stop level with the floor before brake is set. Stopping accuracy shall not exceed a plus or minus 1/4 inch.

### 2.19 JACK UNIT

Jack unit shall be designed and constructed of sufficient size to lift the gross load to the height specified and shall be free from oil leakage. Brittle material such as grey cast iron shall not be used in jack construction. Jack unit shall consist of the following:

- a. Direct displacement plunger fabricated of heavy seamless steel tubing accurately turned and polished.
- b. Stop-ring welded or screwed to the plunger to positively prevent plunger from leaving the cylinder.
- c. Internal guide bearing.
- d. Packing or seal.
- e. Drip ring around cylinder top.
- f. Outer cylinder made of steel tubing.
- g. Air bleeder.
- h. Brackets welded to jack cylinder for supporting the elevator on pit channels.
- i. Scavenger pump with copper tubing connected to the tank.

### 2.20 ELEVATOR SUPPORTS

Structural steel beams, inserts, brackets, bolts and fastening devices shall be provided for proper installation of elevator equipment. Wood plugs are not acceptable.

### 2.21 BUFFERS

Buffers shall be of design suitable for depth of pit. Buffer anchorage at pit floors shall be provided for each car and counterweight and arranged to

avoid puncturing the pit waterproofing. Type of buffer used shall be tested and approved for compliance with elevator service requirements before installation. Pipe struts and steadiers shall be provided as required for pit conditions. A metal plate with information concerning stroke and load-rating shall be permanently fastened to each buffer. Pit-mounted buffers shall have an adequate stroke designed to bring the fully-loaded car and counterweight to rest from governor tripping speed at an average rate of retardation not exceeding gravity. Moving portion of buffer shall be designed to be accelerated by the car without noticeable peak retardation. Spring buffers shall be in accordance with ASME A17.1 A17.1.

## 2.22 LUBRICATION POINTS

Every part subject to movement friction shall be provided with provisions for oil or grease lubrication. All points of lubrication shall be readily accessible.

## 2.23 SEISMIC REQUIREMENTS

Seismic protection shall be provided in conformance with TI 809-04 for general guidance and computation of forces (1.0 G horizontal and 1.0 G vertical minimum), ASME A17.1, Rule XXIV, and ICBO Building Code. The Contractor shall hire a registered engineer to submit the stamped calculations and drawings.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Elevators and equipment shall be installed in accordance with ASME A17.1 and manufacturer's recommendation. Guide rails shall be set plumb and parallel and attached to guide rail brackets secured to building structure as required by the elevator manufacturer and at intervals complying with ASME A17.1. Steel shim plates shall be used for aligning equipment. Guide rail sections shall be joined together in accordance with ASME A17.1. Guide rails shall be thoroughly cleaned and made smooth before elevator is put into operation. During installation all stainless steel shall be protected.

## 3.2 FIELD WELDING

When structural or load-bearing members are to be field welded, welding and qualification of welders shall be as specified in Section 05055WELDING, STRUCTURAL.

## 3.3 CASING, CYLINDER AND PLUNGER UNIT

A steel casing minimum 8 inches larger in diameter than the cylinder sealed at bottom with steel plate shall be complete with provisions to accommodate a double wall cylinder. Casing shall be accurately positioned, plumbed and set to accept the cylinder. The cylinder shall be protected from corrosion by totally enclosing the cylinder with a separate schedule 80, polyvinyl chloride jacket or with a high density, fused polyethylene coating, recommended by the manufacturer. Area between casing and cylinder wall shall be filled with washed dry sand after cylinder has been accurately located. Top of casing shall be sealed. The work of boring the well and setting the cylinder shall be coordinated with construction of concrete pit.

### 3.4 ELEVATOR WIRING

Wiring shall be provided for electrically-operated items of elevator equipment to comply with requirements of NFPA 70 and Section 16415 ELECTRICAL WORK, INTERIOR. For power and lighting circuits wire shall be minimum No. 10 AWG. Work light fixtures equipped with 150 watt incandescent lamps and ground duplex receptacles shall be provided at top and bottom of car. Work light fixtures and traveling cable junction boxes shall be located to provide illumination at junction boxes. Wiring shall terminate in junction boxes. Wires shall be identified and shall match symbols shown on wiring diagrams. Control and signal wires shall be brought to accessible numbered terminal blocks on the controller. Intra-panel wiring shall be flame-resistant type.

#### 3.4.1 Traveling Cables

Cables shall terminate at numbered terminal blocks in car and machine room. Traveling cable shall be provided with a separate shielded circuit for communication system and hang to obtain proper size of loop. Traveling cable shall be provided with 10 percent spare conductors for each car.

### 3.5 PAINTING AND PIPE COLOR CODE MARKING

Except for factory-finished items and corrosion-resistant items, machined surfaces shall be painted as specified in Section 09900 PAINTING, GENERAL. Color Code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

### 3.6 TESTING

Testing shall be in accordance with requirements of ASME A17.1 and ASME A17.2.2; and as specified below. The Contractor shall conduct a complete test of the system. After the system has passed all tests, the Contractor shall notify the Contracting Officer in writing, 14 days prior to the time of performing the acceptance test, that the system is complete and is ready for final acceptance testing. The Contractor after receiving written approval from the Contracting Officer will conduct a complete acceptance test of the system. Final testing will be witnessed by a certified government elevator inspector and the Contractor shall provide the services of an elevator inspector, employed by an independent testing company to inspect the elevators, witness the final testing and certify the elevators.

The inspector shall meet all qualification requirements of ASME QEI-1 and shall be certified in accordance with ASME QEI-1. The Contractor shall provide an elevator certificate signed by the inspector for each elevator. The certificate shall be provided to the Contracting Officer within 30 day after the completion of all testing.

#### 3.6.1 Testing Period

Each elevator shall be tested with the specified rated-load in car continuously for a period of 35 percent of the duty time. During the test run the car shall be stopped at all floors in both directions of travel for a standing period of 10 seconds per floor. A manual test of the final limits (UP and DOWN overtravel) shall also be performed.

#### 3.6.2 Speed Load Testing

The actual speed of elevator car in both directions of travel shall be

determined with the rated-load and with no-load in the elevator car. Actual measured speed of car with the rated-load in the UP direction shall be within 5 percent of rated speed. The maximum difference in actual measured speeds obtained under the various conditions outlined shall not exceed 10 percent of the total difference between the UP and DOWN speeds.

### 3.6.3 Car Leveling Testing

Elevator car-leveling devices shall be tested for accuracy of landing at all floors with no-load in car, with symmetrical load in car and with the rated-load in car in both directions of travel.

### 3.6.4 Temperature Rise Testing

Temperature rise of hydraulic pump motor, motor drive, exciter and booster shall be conducted during the full-load test run for minimum one hour. Under these conditions, temperature rise of equipment shall not exceed the requirements established in NEMA MG 1 Chapter 12. Test shall be started when all parts of equipment are within the temperature required by NEMA at time of starting tests.

### 3.6.5 Insulation-Resistance Testing

Insulation-resistance testing shall be performed to ensure that the complete elevator wiring systems will be free from short circuits and grounds. Electrical conductors shall have an insulation-resistance of not less than 1 megohm between each conductor and ground, and not less than 1 megohm between each conductor and all other conductors. Prior to testing, provisions shall be made to prevent damage to electronic devices.

## 3.7 FRAMED INSTRUCTIONS

Two sets of instructions shall be typed and framed under glass or in laminated plastic, and posted side-by-side in the elevator room where directed before acceptance of elevator systems. First set of instructions shall include wiring and control diagrams showing the complete layout of elevator system. Second set of instructions shall include the condensed operating instructions describing preventive maintenance procedures, the methods for checking the elevator system for normal safe operation, and the procedures for safely starting and stopping the elevator system.

## 3.8 OPERATOR TRAINING

Contractor shall conduct a formal training course for operating Government personnel which shall include care, lubrication, adjustment and maintenance of elevator equipment. Training period shall consist of a total of two sessions of four hours each of normal working time and shall start after the system is functionally completed but prior six months after final acceptance tests. Minimum of one session shall be provided immediately prior to final acceptance tests. Field instructions shall cover all of the items contained in the operating and maintenance instructions, including demonstrations of routine maintenance operations. Contracting Officer shall be notified at least 14 days prior to date of starting the training course.

-- End of Section --

## SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS  
04/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(2000) Cellular Glass Thermal Insulation
ASTM C 553	(1999) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 610	(1999) Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C 612	(2000) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation

ASTM C 795	(1992; R 1998e1) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1290	(1995) Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards
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## 1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Insulation of heat distribution systems and chilled water systems outside of buildings shall be as specified in Section 02555 PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

## 1.3 GENERAL QUALITY CONTROL

### 1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

### 1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

### 1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-04 Samples

#### Thermal Insulation Materials;

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For

each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

## 1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

## PART 2 PRODUCTS

### 2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

#### 2.1.1 Adhesives

##### 2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

##### 2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

##### 2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented white and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

#### 2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below

200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F.

The adhesive shall be nonflammable and fire resistant.

#### 2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

#### 2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

#### 2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M.

All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

#### 2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

#### 2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

#### 2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

##### 2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

##### 2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or

3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch) thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

#### 2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

#### 2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

##### 2.1.9.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

##### 2.1.9.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

#### 2.1.10 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

### 2.2 PIPE INSULATION MATERIALS

Insulation materials shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS. Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

#### 2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for outdoor, indoor, exposed or concealed applications, shall be as follows:

- a. Cellular Glass: ASTM C 552, Type II, and Type III. Supply the

insulation with manufacturer's recommended factory applied jacket.

- b. Flexible Elastomeric Cellular Insulation: ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.
- d. Mineral Fiber: ASTM C 547

#### 2.2.2 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

- a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.
- c. Cellular Glass: ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.
- d. Flexible Elastomeric Cellular Insulation: ASTM C 534, Type I or II to 200 degrees F service.

#### 2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

##### 2.3.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, & IV.

##### 2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I, or Type II up to 250 F. ASTM C 1290 Type III.

##### 2.3.3 Cellular Glass

ASTM C 552, Type I.

##### 2.3.4 Polyisocyanurate

ASTM C 591, Type 1. Supply the insulation with manufacturer's recommended factory applied jacket.

#### 2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

##### 2.4.1 Cold Equipment Insulation

For temperatures below 60 degrees F.

###### 2.4.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

###### 2.4.1.2 Flexible Elastomeric Cellular Insulation

ASTM C 534, Type II.

#### 2.4.2 Hot Equipment Insulation

For temperatures above 60 degrees F.

##### 2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, IV, or V as required for temperature encountered to 1800 degrees F.

##### 2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type I, II, III, IV, V, VI or VII as required for temperature encountered to 1200 degrees F.

##### 2.4.2.3 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

##### 2.4.2.4 Flexible Elastomeric Cellular Insulation

ASTM C 534, Type II, to 200 degrees F.

##### 2.4.2.5 Molded Expanded Perlite

ASTM C 610.

##### 2.4.2.6 Polyisocyanurate Foam:

ASTM C 591, Type I. Supply the insulation with manufacturer's recommended factory applied jacket.

### PART 3 EXECUTION

#### 3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after one hour period; any insulation found to pull apart after one hour shall be replaced.

##### 3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall

be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

### 3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

### 3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

### 3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

### 3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

### 3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

## 3.2 PIPE INSULATION INSTALLATION

### 3.2.1 Pipe Insulation

#### 3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, fixtures for

use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.

- c. Sanitary drain lines.
- d. Air chambers.

### 3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.
- c. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.
- h. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inch.
- i. For domestic cold water pipes supplying lavatories or other similar cooling service which requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inch.

## 3.2.1.3 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400 PLUMBING, GENERAL PURPOSE.
- c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate shall be installed above each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.
- d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.
- e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in high abuse areas.

In high abuse areas such as janitor closets and traffic areas in equipment rooms, and mechanical rooms, stainless steel jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.

3.2.2 Aboveground Cold Pipelines

The following cold pipelines shall be insulated per Table I minus 30 degrees to plus 60 degrees F:

- a. Domestic cold .
- b. Make-up water.
- c. Horizontal and vertical portions of interior roof drains.
- d. Refrigerant suction lines.
- e. Chilled water.
- g. Air conditioner condensate drains.
- i. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness  
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Refrigerant suction piping	CG		1.5	1.5	1.5	1.5	1.5
	FC		1.0	1.0	1.0	1.0	1.0
Chilled water supply & return piping	CG	1.5	1.5	1.5	2.0	2.0	2.0
	FC	0.5	1.0	1.0	1.0	1.0	1.0
Cold domestic	CG	1.5	1.5	1.5	1.5	1.5	1.5

Table I - Cold Piping Insulation Thickness  
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
water, above and below ceilings & makeup water	FC	3/8	3/8	3/8	3/8	3/8	3/8
Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap personnel	FC MF	0.5 0.5	0.5 1.0	0.5 1.0	0.5 1.5	3/4 1.5	3/4 1.5
Horizontal & vertical roof drain leaders (including underside of roof drain fitting)	FC		0.5	0.5	0.5	0.5	0.5
Air conditioning condensate drain located inside building	FC		3/8	0.5	0.5	N/A	N/A

\*When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like main feed pipe.

LEGEND:

CG - Cellular Glass

MF - Mineral Fiber

FC - Flexible Elastomeric Cellular

3.2.2.2 Jacket for Mineral Fiber, and Cellular Glass, Phenolic Foam, and Polyisocyanurate Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 6 ft level will be protected.

## 3.2.2.3 Insulation for Straight Runs (Mineral Fiber, and Cellular Glass, )

- a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with a vapor retarder coating.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per paragraph 3.2.2.3 e.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 1-1/2 inches past the break.
- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

## 3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be coated with vapor retarder coating.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".
- c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of

vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.
- e. Insulation shall be marked showing the location of unions, strainers, and check valves.

#### 3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

#### 3.2.3 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

- a. Domestic hot water supply & recirculating system.
- d. Hot water heating.

##### 3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

##### LEGEND:

CG - Cellular Glass  
MF - Mineral Fiber  
FC - Flexible Elastomeric Cellular

Table II - Hot Piping Insulation Thickness  
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Hot domestic water supply & recirculating system,	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	0.5	0.5	1.0	1.0	1.5	1.5
	MF	0.5	1.5	1.5	1.5	1.5	
Heating hot water, supply & return,	CG	1.5	1.5	2.0	2.0	2.5	3.0
	MF	0.5	1.5	1.5	2.0	2.5	3.0

\* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

\*\* Applies to recirculating sections of service or domestic hot water systems and first 8 feet from storage tank for non-recirculating systems.

### 3.2.3.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Elastomeric Cellular

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

### 3.2.3.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

- f. Flexible elastomeric cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

#### 3.2.3.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12, and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".
- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.
- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

#### 3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an

aluminum jacket or PVC jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it, however an all service jacket shall be applied if factory applied jacketing is not furnished. Flexible elastomeric cellular insulation exposed to weather shall be treated in accordance with paragraph INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION.

#### 3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12 inch centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 60 degrees F and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 60 degrees F and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 60 degrees F shall be sealed with a moisture retarder.

#### 3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof.

#### 3.2.4.3 PVC Jacket

PVC jacket shall be ultraviolet resistant and adhesive welded weather tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

### 3.3 DUCT INSULATION INSTALLATION

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

#### 3.3.1 Duct Insulation Thickness

Table III - Minimum Duct Insulation (inches)

Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5

Table III - Minimum Duct Insulation (inches)  
Fresh Air Intake Ducts 1.5

### 3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation and vapor retarder shall be provided for the following cold air ducts and associated equipment.

- a. Supply ducts.
- b. Return air ducts.
- c. Relief ducts.
- d. Flexible runouts (field-insulated).
- e. Plenums.
- f. Duct-mounted coil casings.
- g. Coil headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes (field-insulated).
- n. Ducts exposed to weather.
- o. Combustion air intake ducts.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf.

Insulation for round/oval ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I or II jacket; or, a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I or II all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. Insulation on concealed duct shall be provided with a factory-applied Type I or II vapor retarder jacket. The total dry film thickness shall be approximately 1/16 inch.. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation. Sheet Metal Duct shall be sealed in accordance with CECS 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

#### 3.3.2.1 Installation on Concealed Duct

- a. For rectangular, or round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.
- b. For rectangular ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- c. For rectangular, and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.
- d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.
- f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating.
- g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating.
- h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.
- i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.
- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

### 3.3.3 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, ducts shall be insulated as specified for cold air duct.

### 3.3.4 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be

repaired.

### 3.4 EQUIPMENT INSULATION INSTALLATION

#### 3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

- a. Handholes.
- b. Boiler manholes.
- c. Cleanouts.
- d. ASME stamps.
- e. Manufacturer's nameplates.

#### 3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

- a. Pumps.
- b. Refrigeration equipment parts that are not factory insulated.
- c. Drip pans under chilled equipment.
  
- g. Cold and chilled water pumps.
  
- i. Roof drain bodies.
- j. Air handling equipment parts that are not factory insulated.
- k. Expansion and air separation tanks.

##### 3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

- a. Equipment handling media between 35 and 60 degrees F: 1.5 inch thick cellular glass, 1 inch thick flexible elastomeric cellular,

##### 3.4.2.2 Pump Insulation

- a. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box

shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

- b. Exposed insulation corners shall be protected with corner angles.
- c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

#### 3.4.2.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. Cellular glass insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer.
- d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.
- e. Exposed insulation corners shall be protected with corner angles.
- f. Insulation on equipment with ribs shall be applied over 6 x 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch centers.

#### 3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

## 3.4.3 Insulation for Hot Equipment

Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

- e. Pumps handling media above 130 degrees F.
- h. Air separation tanks.
- m. Boiler flue gas connection from boiler to stack (if inside).
- n. Induced draft fans.

## 3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium.

Insulation thickness for hot equipment shall be determined using Table IV:

## Legend

RMF: Rigid Mineral Fiber  
 FMF: Flexible Mineral Fiber  
 CS: Calcium Silicate  
 PL: Perlite  
 CG: Cellular Glass  
 FC: Flexible Elastomeric Cellular  
 PF: Phenolic Foam  
 PC: Polyisocyanurate Foam

TABLE IV  
 Insulation Thickness for Hot Equipment (mm)

Equipment handling steam or other media to indicated pressure or temperature limit	Material	Thickness
103.4 kPa or 121 C	RMF	50 mm
	FMF	50 mm
	CS/PL	100 mm
	CG	75 mm
	PF	40 mm
	FC(<93 C)	25 mm
1379.0kPa or 204 C	PC	25 mm
	RMF	75 mm
	FMF	75 mm
	CS/PL	100 mm
316 C	CG	100 mm
	RMF	125 mm
	FMF	150 mm
	CS/PL	150 mm

CG

150 mm

316 C: Thickness necessary to limit the external temperature of the insulation to 50 C, except that diesel engine exhaust piping and mufflers shall be covered with 150 mm thick material suitable for 650 degrees C service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

TABLE IV  
Insulation Thickness for Hot Equipment (Inches)

Equipment handling steam or media to indicated pressure or temperature limit:	Material	Thickness
15 psig or 250F	RMF	2.0 inches
	FMF	2.0 inches
	CG	3.0 inches
	FC (<200F)	1.0 inches

#### 3.4.3.2 Insulation of Pumps

Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line of the removable sections and penetrations.

#### 3.4.3.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible elastomeric cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the

manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

- e. Exposed insulation corners shall be protected with corner angles.
- f. On equipment with ribs, such as boiler flue gas connection, draft fans, and fly ash or soot collectors, insulation shall be applied over 6 x 6 inch by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 inch washers or shall be securely banded or wired in place on 12 inch (maximum) centers.
- h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

#### 3.4.4 Equipment Handling Dual Temperature Media

Below and above 60 degrees F: equipment handling dual temperature media shall be insulated as specified for cold equipment.

#### 3.4.5 Equipment Exposed to Weather

##### 3.4.5.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

##### 3.4.5.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for weatherproof installation and shall prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.

-- End of Section --

## SECTION 15190

GAS PIPING SYSTEMS  
02/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN GAS ASSOCIATION (AGA)

AGA Manual (1994; Addenda/Correction Jan 1996) A.G.A. Plastic Pipe Manual for Gas Service

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.45 (1995) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances

ANSI Z21.69 (1992; Z21.69a) Connectors for Movable Gas Appliances

## AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D (1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 539 (1999) Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines

ASTM B 88 (1999) Seamless Copper Water Tube

ASTM B 210 (1995a) Aluminum and Aluminum-Alloy Drawn Seamless Tubes

ASTM B 241/B 241M (1999) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

ASTM B 280 (1999) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

ASTM D 2513 (1999a) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

ASTM D 2517 (1999) Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

## ASME INTERNATIONAL (ASME)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General

	Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.33	(1990) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (Sizes 1/2 through 2)
ASME B31.1	(1998) Power Piping
ASME B31.2	(1968) Fuel Gas Piping
ASME B36.10M	(1996) Welded and Seamless Wrought Steel Pipe
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	
MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 54	(1999) National Fuel Gas Code
NFPA 70	(1999) National Electrical Code
THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)	
SSPC SP 6/NACE 3	(1994) Commercial Blast Cleaning
UNDERWRITERS LABORATORIES (UL)	
UL Gas&Oil Dir	(1999) Gas and Oil Equipment Directory

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL.

#### 1.2.2 Jointing Thermoplastic and Fiberglass Piping

Piping shall be jointed by performance qualified joiners using qualified procedures in accordance with AGA Manual. Plastic Pipe Manual for Gas Service. The Contracting Officer shall be furnished with a copy of qualified procedures and list of and identification symbols of qualified joiners.

#### 1.2.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

#### 1.2.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Gas Piping System; G, AE.

Drawings showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

#### SD-03 Product Data

#### SD-6 Test Reports

Testing;

Pressure Tests;

Test With Gas;

Test reports in booklet form tabulating test and measurements performed. The reports shall be dated after award of this contract, shall state the contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

## PART 2 PRODUCTS

### 2.1 PIPE AND FITTINGS

#### 2.1.1 Steel Pipe, Joints, and Fittings

Steel pipe shall conform to ASME B36.10M. Malleable-iron threaded fittings shall conform to ASME B16.3. Steel pipe flanges and flanged fittings including bolts, nuts, and bolt pattern shall be in accordance with ASME B16.5. Wrought steel butt welding fittings shall conform to ASME B16.9. Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

#### 2.1.2 Aluminum Alloy Pipe and Tubing, Joints, and Fittings

Aluminum alloy pipe shall conform to ASTM B 241/B 241M, except alloy 5456 shall not be used, and the ends of each length of pipe shall be marked indicating it conforms to NFPA 54. Pipe joints shall be threaded, flanged, brazed or welded.

Aluminum alloy tubing shall conform to , ASTM B 210, Type A or B, or ASTM B 241/B 241M, Type A or equivalent. Tubing joints shall be made up with gas tubing fittings recommended by the tubing manufacturer.

#### 2.1.3 Copper Tubing, Joints and Fittings

Copper tubing shall conform to ASTM B 88, Type K or L, or ASTM B 280. Tubing joints shall be made up with tubing fittings recommended by the tubing manufacturer.

#### 2.1.4 Steel Tubing, Joints and Fittings

Steel tubing shall conform to ASTM A 539. Tubing joints shall be made up with gas tubing fittings recommended by the tubing manufacturer.

#### 2.1.5 Thermoplastic Pipe, Tubing, Joints, and Fittings

Thermoplastic pipe, tubing, joints and fittings shall conform to ASTM D 2513.

#### 2.1.6 Fiberglass Pipe, Joints, and Fittings

Fiberglass piping systems shall conform to ASTM D 2517.

#### 2.1.7 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL Gas&Oil Dir, Class 20 or less. Tetrafluoroethylene tape shall conform to UL Gas&Oil Dir.

### 2.1.8 Identification

Pipe flow markings and metal tags shall be provided as required.

### 2.1.9 Flange Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 600 degree F service. NBR binder shall be used for hydrocarbon service.

### 2.1.10 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

### 2.1.11 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

### 2.1.12 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing metallic and thermoplastic or fiberglass pipe. Approved transition fittings are those that conform to AGA Manual requirements for transition fittings.

### 2.1.13 Insulating Pipe Joints

#### 2.1.13.1 Insulating Joint Material

Insulating joint material shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

#### 2.1.13.2 Threaded Pipe Joints

Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

#### 2.1.13.3 Flanged Pipe Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

### 2.1.14 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.45. Flexible connectors for movable food service equipment shall conform to ANSI Z21.69.

## 2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

### 2.2.1 Valves 2 Inches and Smaller

Valves 2 inches and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

### 2.2.2 Valves 2-1/2 Inches and Larger

Valves 2-1/2 inches and larger shall be carbon steel conforming to API Spec 6D, Class 150.

## 2.3 PIPE HANGERS AND SUPPORTS

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

## 2.4 PRESSURE REGULATORS

Regulators shall have ferrous bodies, shall provide backflow and vacuum protection, and shall be designed to meet the pressure, load and other service conditions.

### 2.4.1 Gas Regulators

Pressure regulators for individual service lines shall have ferrous bodies.

Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of water column. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulator shall have single port with orifice diameter no greater than recommended by the manufacturer for the maximum gas pressure at the regulator inlet.

## PART 3 EXECUTION

### 3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02316 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.2 GAS PIPING SYSTEM

Gas piping system shall be from the point of delivery, defined as the outlet of the meter set assembly, specified in Section 02556 GAS DISTRIBUTION SYSTEM, to the connections to each gas utilization device.

#### 3.2.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

#### 3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.

### 3.3 PROTECTIVE COVERING

#### 3.3.1 Underground Metallic Pipe

Buried metallic piping shall be protected from corrosion with protective coatings as specified in Section 02556 GAS DISTRIBUTION SYSTEM. When dissimilar metals are joined underground, gastight insulating fittings shall be used.

#### 3.3.2 Aboveground Metallic Piping Systems

##### 3.3.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, loose mill scale and other foreign substances shall be mechanically cleaned by power wire brushing or commercial sand blasted conforming to SSPC SP 6/NACE 3 and primed with ferrous metal primer or vinyl type wash coat. Primed surface shall be finished with two coats of exterior oil paint or vinyl paint.

##### 3.3.2.2 Nonferrous Surfaces

Except for aluminum alloy pipe, nonferrous surfaces shall not be painted. Surfaces of aluminum alloy pipe and fittings shall be painted to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. The surfaces shall be solvent-cleaned and treated with vinyl type wash coat. A first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel shall be applied.

### 3.4 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, AGA Manual, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 6 inches and larger, an approved gas cutting and beveling machine may be used. Cutting of thermoplastic and fiberglass pipe shall be in accordance with AGA Manual.

#### 3.4.1 Metallic Piping Installation

Underground piping shall be buried a minimum of 18 inches below grade. Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Aluminum alloy pipe shall not be used in exterior locations or underground.

#### 3.4.2 Metallic Tubing Installation

Metallic tubing shall be installed using gas tubing fittings approved by the tubing manufacturer. Branch connections shall be made with tees. All tubing end preparation shall be made with tools designed for the purpose. Aluminum alloy tubing shall not be used in exterior locations or

underground.

### 3.4.3 Thermoplastic and Fiberglass Piping, Tubing, and Fittings

Thermoplastic and fiberglass piping, tubing, and fittings shall be installed outside and underground only. Piping shall be buried a minimum of 18 inches below grade. The piping shall be installed to avoid excessive stresses due to thermal contraction. Thermoplastic and fiberglass piping shall only be allowed as indicated.

### 3.4.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

### 3.4.5 Concealed Piping in Buildings

When installing piping which is to be concealed, unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combinations of fittings shall not be used.

#### 3.4.5.1 Piping in Partitions

Concealed piping shall be located in hollow rather than solid partitions. Tubing passing through walls or partitions shall be protected against physical damage.

### 3.4.6 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported. Exposed horizontal piping shall not be installed farther than 6 inches from nearest parallel wall in laundry areas where clothes hanging could be attempted.

### 3.4.7 Final Gas Connections

Unless otherwise specified, final connections shall be made with rigid metallic pipe and fittings. Provide accessible gas shutoff valve and coupling for each gas equipment item.

## 3.5 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

### 3.5.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 1-1/2 inches in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 2 inches in diameter may be made with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

### 3.5.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

### 3.5.3 Thermoplastic and Fiberglass Joints

Jointing procedures shall conform to AGA Manual. Solvent cement or heat of fusion joints shall not be made between different kinds of plastics.

### 3.5.4 Flared Metallic Tubing Joints

Flared joints in metallic tubing shall be made with special tools recommended by the tubing manufacturer. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Metallic ball sleeve compression-type tubing fittings shall not be used for tubing joints.

### 3.5.5 Solder or Brazed Joints

Joints in metallic tubing and fittings shall be made with materials and procedures recommended by the tubing supplier. Joints shall be brazed with material having a melting point above 1000 degrees F. Brazing alloys shall not contain phosphorous.

### 3.5.6 Joining Thermoplastic or Fiberglass to Metallic Piping or Tubing

When compression type mechanical joints are used, the gasket material in the fittings shall be compatible with the plastic piping and with the gas in the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting, and the stiffener shall be flush with end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. A split tubular stiffener shall not be used.

## 3.6 PIPE SLEEVES

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Sleeves in mechanical room floors above grade shall extend at least 4 inches above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 1/4 inch all around the pipe. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on

grade, the annular space between the pipe and sleeve shall be sealed with firestopping material and sealant that meet the requirement of Section 07840 FIRESTOPPING.

### 3.7 PIPES PENETRATING WATERPROOFING MEMBRANES

Pipes penetrating waterproofing membranes shall be installed as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

### 3.8 FIRE SEAL

Penetrations of fire rated partitions, walls and floors shall be in accordance with Section 07840 FIRESTOPPING.

### 3.9 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

### 3.10 SPECIAL REQUIREMENTS

Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall conform to the requirements of NFPA 54.

### 3.11 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched.

### 3.12 PIPING SYSTEM SUPPORTS

Gas piping systems in buildings shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 1/8 inch shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

### 3.13 ELECTRICAL BONDING AND GROUNDING

The gas piping system within the building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70. Conventional flange joints allow sufficient current flow to satisfy this requirement.

### 3.14 SHUTOFF VALVE

Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

### 3.15 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. Prior to testing, the system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.

#### 3.15.1 Pressure Tests

Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 0.1 pound. The source of pressure shall be isolated before the pressure tests are made.

#### 3.15.2 Pressure Tests for Liquified Petroleum Gas

Systems shall withstand the pressure test described above. When appliances are connected to the piping system, fuel gas shall be used for testing and appliances shall withstand a pressure of not less than 10.0 inches nor more than 14.0 inches water column (8.0 ounces per square inch) for a period of not less than 10 minutes without showing any drop in pressure. Pressure shall be measured with a water manometer or an equivalent device calibrated to be read in increments of not greater than 0.1 inch water column. The source of pressure shall be isolated before the pressure tests are made.

#### 3.15.3 Test With Gas

Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

#### 3.15.4 Purging

After testing is completed, and before connecting any appliances, all gas piping shall be fully purged. LPG piping tested using fuel gas with appliances connected does not require purging. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

#### 3.15.5 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.16 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900  
PAINTING, GENERAL.

-- End of Section --

## SECTION 15400

PLUMBING, GENERAL PURPOSE  
02/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 700 (1995; Apx C) Specifications for  
Fluorocarbon and Other Refrigerants

ARI 1010 (1994) Self-Contained, Mechanically  
Refrigerated Drinking-Water Coolers

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.10.1 (1993; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas  
Water Heaters Vol. I, Storage Water Heaters  
with Input Ratings of 75,000 Btu Per Hour  
or Less

ANSI Z21.10.3 (1998) Gas Water Heaters Vol. III, Storage  
Water Heaters with Input Ratings Above  
75,000 Btu Per Hour, Circulating and  
Instantaneous Water Heaters

ANSI Z21.22 (1986; Z21.22a) Relief Valves and Automatic  
Gas Shutoff Devices for Hot Water Supply  
Systems

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M (1999b) Pipe, Steel, Black and Hot-Dipped,  
Zinc-Coated, Welded and Seamless

ASTM A 74 (1998) Cast Iron Soil Pipe and Fittings

ASTM A 105/A 105M (1998) Carbon Steel Forgings for Piping  
Applications

ASTM A 193/A 193M (1999a) Alloy-Steel and Stainless Steel  
Bolting Materials for High-Temperature  
Service

ASTM A 515/A 515M (1989; R 1997) Pressure Vessel Plates,  
Carbon Steel, for Intermediate- and  
Higher-Temperature Service

ASTM A 516/A 516M (1990; R 1996) Pressure Vessel Plates,  
Carbon Steel, for Moderate- and

## Lower-Temperature Service

ASTM A 733	(1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1998el) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1998) Seamless Red Brass Pipe, Standard Sizes
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM B 306	(1999) Copper Drainage Tube (DWV)
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM B 584	(1998a) Copper Alloy Sand Castings for General Applications
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1998) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 2235	(1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2661	(1997ael) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(1998) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2822	(1991; R 1997el) Asphalt Roof Cement
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

ASTM D 3122	(1995) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings
ASTM D 3138	(1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1	(1998) ASTM Thermometers
ASTM F 409	(1999a) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 628	(1999e1) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 891	(1998e1) Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F 1760	(1997) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 34	(1997) Number Designation and Safety Classification of Refrigerants
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ASME INTERNATIONAL (ASME)

ASME A112.1.2	(1991; R 1998) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.14.1	(1975; R 1998) Backwater Valves

ASME A112.19.1M	(1994; R 1999) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	(1998) Vitreous China Plumbing Fixtures
ASME A112.19.3M	(1987; R 1996) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.21.1M	(1991; R 1998) Floor Drains
ASME A112.36.2M	(1991; R 1998) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a1994) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1998) Controls and Safety Devices for Automatically Fired Boilers
AMERICAN SOCIETY OF SANITARY ENGINEERING FOR PLUMBING AND SANITARY RESEARCH(ASSE)	
ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1003	(1995) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1986) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1011	(1995) Hose Connection Vacuum Breakers
ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1020	(1998) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage)
ASSE 1037	(1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures
AMERICAN WATER WORKS ASSOCIATION (AWWA)	
AWWA EWW	(1999) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1997; addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

## AMERICAN WELDING SOCIETY (AWS)

- AWS A5.8 (1992) Filler Metals for Brazing and Braze Welding
- AWS B2.2 (1991) Brazing Procedure and Performance Qualification

## CAST IRON SOIL PIPE INSTITUTE (CISPI)

- CISPI 301 (1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- CISPI 310 (1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- CISPI HSN-85 (1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

## CODE OF FEDERAL REGULATIONS (CFR)

- 10 CFR 430 Energy Conservation Program for Consumer Products
- PL 93-523 (1974; Amended 1986) Safe Drinking Water Act

## COPPER DEVELOPMENT ASSOCIATION (CDA)

- CDA Tube Handbook (1995) Copper Tube Handbook

## FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

- FCCCHR-01 (1993) Manual of Cross-Connection Control

## HYDRAULIC INSTITUTE (HI)

- HI 1.1-1.5 (1994) Centrifugal Pumps

## INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

- IAPMO Z124.5 (1997) Plastic Toilet (Water Closets) Seats

## INTERNAL CODE COUNCIL (ICC)

- CABO A117.1 (1998) Accessible and Usable Buildings and Facilities
- ICC Plumbing Code (2000) International Plumbing Code (IPC)

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

- MSS SP-25 (1998) Standard Marking System for Valves,

## Fittings, Flanges and Unions

MSS SP-44	(1996) Steel Pipeline Flanges
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(1991; R 1996) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(1995) Class 3000 Steel Pipe Unions Socket-Welding and Threaded
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS  
(NAPHCC)

NAPHCC Plumbing Code	(1996) National Standard Plumbing Code
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1999) National Fuel Gas Code
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 14	(1999) Plastics Piping Components and Related Materials
NSF 61	(1999) Drinking Water System Components - Health Effects (Sections 1-9)
PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)	
PPFA-01	(1999) Plastic Pipe in Fire Resistive Construction
PLUMBING AND DRAINAGE INSTITUTE (PDI)	
PDI WH 201	(1992) Water Hammer Arresters
SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)	
SAE J 1508	(1997) Hose Clamps

## 1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

## 1.3 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Plumbing System; G, AE.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and

operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics;G, AE.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

#### SD-03 Product Data

Welding;

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Plumbing Fixture Schedule; G, AE.

Catalog cuts of related piping system and system location where installed.

Vibration-Absorbing Features; G, AE.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

Plumbing System; G, AE.

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

#### SD-06 Test Reports

Tests, Flushing and Disinfection;

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Backflow Prevention Assembly Tests; G, AE.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

#### SD-07 Certificates

Materials and Equipment;

Where materials or equipment are specified to comply with requirements of AGA, ASME, or NSF proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts;

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

#### SD-10 Operation and Maintenance Data

Plumbing System;

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

### 1.5 PERFORMANCE REQUIREMENTS

#### 1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

### 1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with ICC Plumbing Code.

### 1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## PART 2 PRODUCTS

## 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II.

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8.

End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

## 2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310
- b. Coupling for Steel Pipe: AWWA C606.
- d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- e. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.
- f. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.
- g. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
- h. Solder Material: Solder metal shall conform to ASTM B 32.
- i. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

- j. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.
- k. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.
- m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.
- o. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.
- p. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.
- q. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.
- r. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.
- s. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.
- t. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

#### 2.1.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrester: PDI WH 201.
- b. Copper, Sheet and Strip for Building Construction: ASTM B 370.
- c. Asphalt Roof Cement: ASTM D 2822.
- d. Hose Clamps: SAE J 1508.
- e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
- f. Metallic Cleanouts: ASME A112.36.2M.
- g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
- h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:  
AWWA C203.
- i. Hypochlorites: AWWA B300.
- j. Liquid Chlorine: AWWA B301.
- k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

m. Thermometers: ASTM E 1.

### 2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

## 2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ANSI Z21.22
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005

Description	Standard
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

### 2.3.1 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

### 2.3.2 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

### 2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 200,000 Btuh shall have 3/4 inch minimum inlets, and 3/4 inch outlets. Relief valves for systems where the maximum rate of heat input is greater than 200,000 Btuh shall have 1 inch minimum inlets, and 1 inch outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

## 2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.

Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

#### 2.4.1 Automatic Flushing System

Flushing system shall consist of solenoid-activated flush valve with electrical-operated light beam sensor to energize solenoid. Flushing devices shall be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS.

#### 2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-01. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

#### 2.6 DRAINS

##### 2.6.1 Floor Drains

Floor drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor shall conform to ASME A112.21.1M.

##### 2.6.2 Boiler Room Drains

Boiler room drains shall have combined drain and trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded

corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 4 inches. The grate area shall be not less than 100 square inches.

### 2.6.3 Sight Drains

Sight drains shall consist of body, integral seepage pan, and adjustable strainer with perforated or slotted grate and funnel extension. The strainer shall have a threaded collar to permit adjustment to floor thickness. Drains shall be of double drainage pattern suitable for embedding in the floor construction. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided for other than concrete construction. Drains shall have a galvanized heavy cast-iron body and seepage pan and chromium-plated bronze, nickel-bronze, or nickel-brass strainer and funnel combination. Drains shall be provided with threaded connection and with a separate cast-iron "P" trap, unless otherwise indicated. Drains shall be circular, unless otherwise indicated. The funnel shall be securely mounted over an opening in the center of the strainer. Minimum dimensions shall be as follows:

Area of strainer and collar	36 square inches
Height of funnel	3-3/4 inches
Diameter of lower portion of funnel	2 inches
Diameter of upper portion of funnel	4 inches

### 2.6.4 Overflow Outlet

Overflow outlet shall be made of cast brass, with wall flange for securing to wall and threaded inlet connection. Unit design shall divert wall away from wall. Size shall be as indicated or no less than vertical rain leader that it is connected to.

## 2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

## 2.8 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Each gas-fired water heater shall have controls with an adjustable range that includes 120 to 180 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

### 2.8.1 Automatic Storage Type

Heaters shall be complete with control system, and shall have ASME rated combination pressure and temperature relief valve.

#### 2.8.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 75,000 BTU per hour or less or ANSI Z21.10.3 for heaters with input greater than 75,000 BTU per hour.

## 2.9 PUMPS

### 2.9.1 Sump Pumps

Sump pumps shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submerged type, complete with necessary control equipment. Motors shall be totally enclosed, of sizes as indicated and shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure. The suction side of each pump shall have a strainer of ample capacity. A float switch assembly, with the switch completely enclosed in a NEMA 250, Type 1 enclosure, shall start and stop each motor at predetermined water levels. The discharge line from each pump shall be provided with a union or flange, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

### 2.9.2 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Pump shall conform to HI 1.1-1.5. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover. Pump motors smaller than Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A gate valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

### 3.1.1 Water Pipe, Fittings, and Connections

#### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

#### 3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

#### 3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

#### 3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions.

Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

#### 3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and gate valve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

#### 3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

#### 3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

### 3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

### 3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

#### 3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

#### 3.1.2.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.2.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

#### 3.1.2.4 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

#### 3.1.2.5 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections.

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

- b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.
- c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

#### 3.1.2.6 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

#### 3.1.2.7 Other Joint Methods

#### 3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

#### 3.1.4 Corrosion Protection for Buried Pipe and Fittings

##### 3.1.4.1 Cast Iron and Ductile Iron

Pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Pipe, fittings, and joints shall have a protective coating. The protective coating shall be completely encasing polyethylene tube or sheet in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer, and wrapped with tape. The pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

##### 3.1.4.2 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and

wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

### 3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

#### 3.1.5.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900 JOINT SEALING. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07840 FIRESTOPPING.

#### 3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be

suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

#### 3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

#### 3.1.5.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

#### 3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07900 JOINT SEALING.

### 3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

### 3.1.7 Supports

#### 3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

#### 3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT . Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

#### 3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

- h. Type 40 shields shall:
  - (1) Be used on insulated pipe less than 4 inches.
  - (2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
  - (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
  - (1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
  - (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
  - (3) On pipe 4 inches and larger carrying medium less than 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.
- n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

### 3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

## 3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

### 3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water

heater.

### 3.2.2 Installation of Gas- Fired Water Heater

Installation shall conform to NFPA 54 for gas fired . Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 24 inches just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

### 3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

### 3.2.4 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

## 3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

### 3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with

approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure.

### 3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 42 inches above floor. Wall-hung service sinks shall be mounted with rim 28 inches above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

### 3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

#### 3.3.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

#### 3.3.4.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

#### 3.3.4.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

#### 3.3.4.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

#### 3.3.4.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

### 3.3.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC Plumbing Code at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

### 3.3.6 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

### 3.3.7 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 2 inches above the flood rim of the funnel to provide an acceptable air gap.

### 3.3.8 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

## 3.4 IDENTIFICATION SYSTEMS

### 3.4.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

### 3.4.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900

PAINTING, GENERAL.

### 3.4.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room.

### 3.5 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

### 3.6 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

### 3.7 TESTS, FLUSHING AND DISINFECTION

#### 3.7.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC Plumbing Code.

- a. Drainage and Vent Systems Tests.
- b. Building Sewers Tests.
- c. Water Supply Systems Tests.

#### 3.7.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of

Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of
Gauges	

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

### 3.7.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

### 3.7.3 System Flushing

#### 3.7.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration.

#### 3.7.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

### 3.7.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.

### 3.7.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter

technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.7.6 Flushing of Potable Water System

As an option to the system flushing specified above, the potable water system shall be flushed and conditioned until the residual level of lead is less than that specified by the base industrial hygienist. The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

## 3.8 PLUMBING FIXTURE SCHEDULE

### P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Seat - IAPMO Z124.5, Type A, black plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 2-5/8 inches at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 1.6 gallons per flush.

### P-2 WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

### P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M siphon jet. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 1 gallon per flush.

### P-4 URINAL HANDICAPPED::

Mounting height at rim shall be in accordance with CABO A117.1; other features are the same as P-3

### P-5 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M under counter mounted, oval.

Faucet - Faucets shall meet the requirements of NSF 61, Section 9. Faucets shall be center set type. Faucets shall have replaceable seats and washers.

Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as a foot switch or fixture occupancy sensor. If a metering

device is not used, the flow shall be limited to 2.5 gpm at a flowing pressure of 80 psi.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel. See paragraph FIXTURES for optional plastic accessories.

P-6 LAVATORY HANDICAPPED:

Faucet shall be in accordance with CABO A117.1; other features are the same as P-5.

P-7 COUNTER SINK:

Ledge back with holes for faucet and spout double bowl 32 x 21 inches stainless steel ASME A112.19.3M.

Faucet and Spout - Faucets shall meet the requirements of NSF 61, Section 9. Cast or wrought copper alloy. Aerator shall have internal threads. Flow shall be limited to 0.25 gallon per cycle at a flowing water pressure of 80 psi if a metering device or fitting is used that limits the period of water discharge such as a foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 2.5 gpm at a flowing water pressure of 80 psi.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-8 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M corner, floor mounted 28 inches square, 6-3/4 inches deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be four arm type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 3 inch diameter.

P-9 WATER COOLER DRINKING FOUNTAINS:

Drinking fountains shall meet the requirements of NSF 61, Section 9. Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 8 gph of water at 50 degrees F with an inlet water temperature of 80 degrees F while residing in a room environment of 90 degrees F, and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish

finish. Spouts shall provide a flow of water at least 4 inches high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall be 13-1/4 inches wide, 13 inches deep, and have a back height of 6 to 8 inches. The bowl shall be made of stainless steel. The unit shall have concealed fasteners and be for interior installation.

#### P-10 WATER COOLER DRINKING FOUNTAIN - HANDICAPPED

Unit shall be in accordance with CABO A117.1; units shall be surface wall-mounted. The dimensions shall be 15 inches wide, 20 inches deep, with a back height of 6 to 8 inches. The unit shall clear the floor or ground by at least 8 inches. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 27 inches and between the front edge of the bowl and the body of the unit of at least 8 inches. A 8 inch wide clear space shall exist on both sides of the unit. The spout height shall be no more than 36 inches above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 6-1/2 inches high, made of stainless steel and be for interior installation.

### 3.9 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

### 3.10 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 70 degrees F delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).

SL = Standby loss in W/sq. ft. based on 80 degrees F delta T, or in percent per hour based on nominal 90 degrees F delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

#### 3.10.1 Storage Water Heaters

##### 3.10.1.1 Gas

- a. Storage capacity of 100 gallons or less, and input rating of 75,000 Btu/h or less: minimum EF shall be 0.62-0.0019V per 10 CFR

430.

## 3.11 TABLES

TABLE I  
PIPE AND FITTING MATERIALS FOR  
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE				
		A	B	C	D	E
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888		X	X	X	
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X	
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X
10	Steel pipe, seamless galvanized, ASTM A 53/A 53M, Type S, Grade B	X			X	X
11	Seamless red brass pipe, ASTM B 43		X	X		
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X
14	Seamless copper pipe, ASTM B 42				X	
15	Cast bronze threaded fittings, ASME B16.15				X	X
16	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X

TABLE I  
 PIPE AND FITTING MATERIALS FOR  
 DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE				
		A	B	C	D	E
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	X	X	X	X	X
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40) ASTM F 1760	X	X	X	X	X

SERVICE:

A - Underground Building Soil, Waste and Storm Drain

B - Aboveground Soil, Waste, Drain In Buildings

C - Underground Vent

D - Aboveground Vent

E - Interior Rainwater Conductors Aboveground

\* - Hard Temper

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE		
		A	B	D
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X
	b. Same as "a" but not galvanized for use with Item 4b			X
4	Steel pipe: a. Seamless, galvanized, ASTM A 53/A 53M, Type S, Grade B	X	X	X
	b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B			
5	Seamless red brass pipe, ASTM B 43	X	X	X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X	X
7	Seamless copper pipe, ASTM B 42	X	X	X
8	Seamless copper water tube, ASTM B 88, ASTM B 88M	X**	X**	** X****
9	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X	
10	Wrought copper and bronzesolder-joint pressure fittings, ASME B16.22 for use with Items 5 and 7	X	X	
11	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 8 and 9	X	X	X
12	Bronze and sand castings grooved joint pressure fittings for non- ferrous pipe ASTM B 584, for use with Item 2	X	X	
32	Steel pipeline flanges,	X	X	

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE		
		A	B	D
	MSS SP-44			
33	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X	
34	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	
35	Malleable-iron threaded pipe unions ASME B16.39	X	X	
36	Nipples, pipe threaded ASTM A 733	X	X	

A - Cold Water Aboveground

B - Hot Water 180 degrees F Maximum Aboveground

D - Cold Water Service Belowground

Indicated types are minimum wall thicknesses.

\*\* - Type L - Hard

\*\*\* - Type K - Hard temper with brazed joints only or type K-soft temper  
without joints in or under floors

\*\*\*\* - In or under slab floors only brazed joints

TABLE III  
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING  
EQUIPMENT

## A. STORAGE WATER HEATERS

FUEL PERFORMANCE	STORAGE CAPACITY GALLONS	INPUT RATING	TEST PROCEDURE	REQUIRED
Gas	100 max.	75,000 Btu/h max.	10 CFR 430	EF = 0.62-0.0019V minimum

## TERMS:

EF = Energy factor, overall efficiency.

V = Storage volume in gallons

-- End of Section --

## SECTION 15569

WATER HEATING; GAS; UP TO 20 MBTUH  
05/95

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 801 (1992) Industrial Process/Power Generation  
Fans: Specification Guidelines

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13 (1991; Z21.13a; Z21.13b) Gas-Fired  
Low-Pressure Steam and Hot Water Boilers

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M (1999b) Pipe, Steel, Black and Hot-Dipped,  
Zinc-Coated, Welded and Seamless

ASTM A 105/A 105M (1998) Carbon Steel Forgings for Piping  
Applications

ASTM A 167 (1999) Stainless and Heat-Resisting  
Chromium-Nickel Steel Plate, Sheet, and  
Strip

ASTM A 193/A 193M (1999a) Alloy-Steel and Stainless Steel  
Bolting Materials for High-Temperature  
Service

ASTM A 234/A 234M (1999) Piping Fittings of Wrought Carbon  
Steel and Alloy Steel for Moderate and High  
Temperature Services

ASTM A 366/A 366M (1997e1) Steel, Sheet, Carbon, Cold-Rolled,  
Commercial Quality

ASTM A 515/A 515M (1989; R 1997) Pressure Vessel Plates,  
Carbon Steel, for Intermediate- and  
Higher-Temperature Service

ASTM A 516/A 516M (1990; R 1996) Pressure Vessel Plates,  
Carbon Steel, for Moderate- and  
Lower-Temperature Service

ASTM A 653/A 653M (1999a) Steel Sheet, Zinc-Coated

	(Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1999) Seamless Copper Tube
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1998) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D 596	(1991; R 1995) Reporting Results of Analysis of Water
ASTM D 1784	(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable

## ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.22 (1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26 (1988) Cast Copper Alloy Fittings for Flared Copper Tubes

ASME B16.34 (1997) Valves - Flanged, Threaded, and Welding End

ASME B16.39 (1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300

ASME B31.1 (1998) Power Piping

ASME B31.5 (1992; B31.5a1994) Refrigeration Piping

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPV IV (1998) Boiler and Pressure Vessel Code; Section IV, Heating Boilers

ASME BPV VIII Div 1 (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASME BPV IX (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ASME CSD-1 (1998) Controls and Safety Devices for Automatically Fired Boilers

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606 (1997) Grooved and Shouldered Joints

## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8 (1992) Filler Metals for Brazing and Braze Welding

AWS B2.2 (1991) Brazing Procedure and Performance Qualification

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419 (Rev D; Canc. Notice 1) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook (1995) Copper Tube Handbook

## EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds (1998; 7th Edition) EJMA Standards

## HYDRONICS INSTITUTE DIVISION OF GAMA (HYI)

HYI-01 (1998) I=B=R Ratings for Boilers, Baseboard  
Radiation and Finned Tube (Commercial)  
Radiation

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-25 (1998) Standard Marking System for Valves,  
Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports -  
Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports -  
Selection and Application

MSS SP-70 (1998) Cast Iron Gate Valves, Flanged and  
Threaded Ends

MSS SP-71 (1997) Gray Iron Swing Check Valves,  
Flanges and Threaded Ends

MSS SP-72 (1999) Ball Valves with Flanged or  
Butt-Welding Ends for General Service

MSS SP-73 (1991; R 1996) Brazing Joints for Copper  
and Copper Alloy Pressure Fittings

MSS SP-78 (1998) Cast Iron Plug Valves, Flanged and  
Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check  
Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves,  
Flanged and Threaded Ends

MSS SP-110 (1996) Ball Valves Threaded,  
Socket-Welding, Solder Joint, Grooved and  
Flared Ends

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (1999) National Fuel Gas Code

NFPA 211 (2000) Chimneys, Fireplaces, Vents, and  
Solid Fuel-Burning Appliances

## UNDERWRITERS LABORATORIES (UL)

UL 795 (1999) Commercial-Industrial Gas Heating  
Equipment

UL 1738 (1993; Rev thru Mar 1998) Venting Systems  
for Gas-Burning Appliances, Categories II,  
III and IV

UL Gas&Oil Dir (1999) Gas and Oil Equipment Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-03 Product Data

Manufacturer's Catalog Data; G,AE.

Manufacturer's catalog data shall be included with the detail drawings for the following items:

Boilers  
Fuel Burning Equipment  
Combustion Control Equipment  
Pumps  
Fittings and Accessories

### Water Treatment System

The data shall show model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements.

### Spare Parts Data;

Spare parts data for each different item of material and equipment, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

Water Treatment Plan;  
Boiler Water Treatment;

Six complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in paragraph BOILER WATER TREATMENT, a list of all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

### Heating System Tests;

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

Qualification;

A statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section.

Field Instructions;

System layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

Tests;

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

SD-06 Test Reports

Heating System Tests;

Test reports for the heating system tests upon completion of testing complete with results.

Water Treatment Tests;

.....a. The water quality test report shall identify the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report.

SD-10 Operation and Maintenance Data

Heating System;

Six complete manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

Water Treatment System;

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality.

1.3 GENERAL REQUIREMENTS

### 1.3.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

### 1.3.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

### 1.3.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Each pressure vessel shall have an approved ASME stamp.

### 1.3.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.

### 1.3.5 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

### 1.3.6 Welding

Boilers and piping shall be welded and brazed in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

## 1.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment.

## 1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be protected from the

weather, humidity and temperature variations, dirt and dust, and other contaminants.

## PART 2 PRODUCTS

### 2.1 BOILERS

Each boiler shall have the output capacity in British thermal units per hour (Btuh) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, forced draft fan, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPV IV. Each boiler shall be of the watertube type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in HYI-01 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

#### 2.1.1 Watertube Boiler

The boiler shall be a bent or flexible type of water tube boiler. Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base. The boiler heating surface area for bent or flexible tube boilers shall be at least 4 square feet per boiler horse power. Bent or flexible tube boilers shall be provided with single or multiple downcomers for circulation without the need for exterior pumping. The tubes for bent or flexible tube boilers shall be designed for replacement without requiring welding or rolling of tubes. Any special tools required for bent or flexible tube removal or installation shall be provided with the boiler.

#### 2.1.2 Hot Water Heating Boilers

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining at least the specified minimum efficiency. The boiler design conditions shall be as follows:

- a. Boiler design pressure 30 psig.
- b. Operating pressure at boiler outlet 20 psig.
- c. Hot water temperature 180 degrees F.
- d. Temperature differential between boiler discharge and system return 20 degrees F.
- e. Water pressure drop 5 psig.

- f. Outdoor ambient air temperature 95 degrees F (max), 20 degrees F (min).
- g. Site elevation 0 feet.
- h. Maximum continuous capacity 216000 Btuh.
- i. Rated capacity 2700000 Btuh.
- k. Gas fired boilers with a capacity of greater than or equal to 300,000 Btuh shall have a thermal efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.

## 2.2 FUEL BURNING EQUIPMENT

Boiler shall be designed to burn gas. Each boiler shall comply with Federal, state, and local emission regulations.

### 2.2.1 Burners

#### 2.2.1.1 Gas Fired Burners and Controls

Burners shall be UL approved mechanical draft burners with all air necessary for combustion supplied by a blower where the operation is coordinated with the burner. Burner shall be provided complete with fuel supply system in conformance with the following safety codes or standards:

- a. Gas-fired units with inputs greater than 400,000 Btuh per combustion chamber shall conform to UL 795. Gas fired units less than 12,500,000 Btuh input shall conform to ANSI Z21.13.

### 2.2.2 Draft Fans

Fans conforming to AMCA 801 forced-draft and induced-draft shall be furnished as an integral part of boiler design. Fans shall be centrifugal with backward-curved blades or axial flow type. Each fan shall be sized for output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a 3 foot station. Forced draft fan bearings shall be air cooled. Induced-draft fans shall be designed for handling hot flue gas at the maximum outlet temperature in the boiler. Induced draft fan housings shall be provided with drain holes to accommodate the drainage of condensation. Induced draft fan bearings shall be air-cooled. Induced draft fan scroll sheets and rotor blades shall have protective liners.

#### 2.2.2.1 Draft Fan Control

Forced-draft centrifugal fans shall have inlet vane controls or shall have variable speed control where indicated. Inlet vanes shall be suitable for use with combustion control equipment. Induced-draft centrifugal fans shall have outlet dampers and shall have variable speed control. Induced-draft fans shall have inlet vane controls. Axial propeller fans shall have variable propeller pitch control.

#### 2.2.2.2 Draft Fan Drives

Fans shall be driven by electric motors. Electric motor shall be totally enclosed nonventilated. Motor starter shall be magnetic across-the-line type with general purpose enclosure and shall be furnished with four auxiliary interlock contacts.

#### 2.2.3 Draft Damper

Boilers shall be provided with automatic dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper shall be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper shall be arranged for automatic operation by means of a damper regulator.

#### 2.2.4 Ductwork

Air ducts connecting the forced-draft fan units with the plenum chamber shall be designed to convey air with a minimum of pressure loss due to friction. Ductwork shall be galvanized sheet metal conforming to ASTM A 653/A 653M. Ducts shall be straight and smooth on the inside with laps made in direction of air flow. Ducts shall have cross-break with enough center height to assure rigidity in the duct section, shall be angle iron braced, and shall be completely free of vibration. Access and inspection doors shall be provided as indicated and required, with a minimum of one in each section between dampers or items of equipment. Ducts shall be constructed with long radius elbows having a centerline radius 1-1/2 times the duct width, or where the space does not permit the use of long radius elbows, short radius or square elbows with factory-fabricated turning vanes may be used. Duct joints shall be substantially airtight and shall have adequate strength for the service, with 1-1/2 x 1-1/2 x 1/8 inch angles used where required for strength or rigidity. Duct wall thickness shall be 16 gauge (0.0598 inch) for ducts 60 inches or less and 12 gauge (0.1046 inch) for ducts larger than 60 inches in maximum dimension. Additional ductwork shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

### 2.3 COMBUSTION CONTROL EQUIPMENT

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The boiler water temperature shall be controlled by a water temperature controller. The equipment shall operate either electrically or pneumatically. On multiple boiler installations, each boiler unit shall have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder shall be furnished.

#### 2.3.1 Electrical controls

Electrical control devices shall be rated at 120 volts and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

#### 2.3.2 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the upper part of the boiler near the water outlet. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent. Controller shall be furnished with necessary equipment to automatically adjust the setting to suit the outside weather conditions. The outside air reset controller shall be operated in such a manner that the operating temperatures required by the boiler manufacturer are not compromised.

### 2.3.3 Boiler Combustion Controls and Positioners

- a. Gas boiler units shall be provided with modulating combustion controls with gas pilot or spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.
- c. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller. Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

### 2.3.4 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR. A 4 inch diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

- a. Flame failure.
- b. Failure to establish pilot flame.
- c. Failure to establish main flame.

- d. Low-water cutoff.
- e. High temperature cutoff.

#### 2.3.4.1 Low-water Cutoff

Low water cutoff shall be float actuated switch or electrically actuated probe type low-water cutoff. Float chamber shall be provided with a blow-down connection. Cutoff shall cause a safety shutdown and sound an alarm when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall be in strict accordance to the latest version of code, ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers.

#### 2.3.4.2 Water Flow Interlock

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

### 2.4 PUMPS

#### 2.4.1 Circulating Pumps

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. Pumps shall be supported on a concrete foundation with a cast iron or structural steel base and shall have a flexible-coupled shaft. The circulating pumps shall be vertical split case type. The pump shaft shall be constructed of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Pump seals shall be capable of withstanding 240 degrees F temperature without external cooling. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service, and shall conform to the requirements of paragraph ELECTRICAL EQUIPMENT. Each pump suction and discharge connection shall be provided with a pressure gauge as specified.

#### 2.4.2 Combination Strainer and Suction Diffuser

A combination strainer and suction diffuser, consisting of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and blowdown outlet, shall be provided on pump suction. The combination strainer and suction diffuser shall be in accordance with ASTM F 1199, except as modified herein.

### 2.5 COLD WATER CONNECTIONS

Connections shall be provided which includes consecutively in line a strainer, backflow prevention device, and water pressure regulator in that order in the direction of the flow. The backflow prevention device shall be provided as indicated and in compliance with Section 15400, PLUMBING, GENERAL PURPOSE. Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be

provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be set to maintain a terminal pressure of approximately, lately 5 psi in excess of the static head on the system and shall operate within a 2 psi tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

## 2.6 HEATING AND VENTILATING UNITS

Heating and ventilating units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.7 AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.8 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPV IV, unless otherwise specified.

### 2.8.1 Conventional Breeching and Stacks

#### 2.8.1.1 Breeching

Each boiler shall be connected to the stack or flue by breeching constructed of black steel sheets not less than 0.0478 inch thick nor less than thickness of stack, whichever is larger. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The clear distance between any portion of the breeching surface and any combustible material shall not be less than that specified in NFPA 211. Joints and seams shall be securely fastened and made airtight. Suitable hinged and gasketed cleanouts shall be provided, which will permit cleaning the entire smoke connection without dismantling. Flexible-type expansion joints shall be provided as required and shall not require packing.

#### 2.8.1.2 Stacks

Prefabricated double wall stacks system shall extend above the roof to the height indicated. The inner stack shall be 304 stainless steel having a thickness of not less than 0.035 inch. The outer stack shall be sheet steel having a thickness of not less than 0.025 inch. A method of maintaining concentricity between the inner and outer stacks shall be incorporated. The joints between the stack sections shall be sealed to prevent flue gas leakage. A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack shall be provided complete with rain hood. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

### 2.8.2 [Enter Appropriate Subpart Title Here]

#### 2.8.2.1 Combustion Air Intake Vent

The combustion air intake piping shall be constructed of Schedule 40 PVC per ASTM D 1784. The vent shall be suitable for the temperature at the

boiler combustion air intake connection point. Each intake shall be provided complete with bird screen.

#### 2.8.2.2 Exhaust Vent

The exhaust vent piping shall be constructed of Schedule 40 CPVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. The exhaust vent shall be suitable for the maximum anticipated boiler exhaust temperature and shall withstand the corrosive effects of the condensate. A 0.3125 inch diameter hole shall be provided in the stack not greater than 6 inches from the boiler flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each exhaust stack shall be provided complete with bird screen.

#### 2.8.3 Expansion Tank

The hot water pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The sizes shall be as indicated. The expansion tank shall be welded steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 125 psi and precharged to the minimum operating pressure. The tank's air chamber shall be fitted with an air charging valve and pressure gauge. The tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 250 degrees F.

#### 2.8.4 Air Separator

External air separation tank shall be steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 125 psi. The capacity of the air separation tank indicated is minimum.

#### 2.8.5 Filters

Filters shall conform to ASTM F 872 or CID A-A-1419.

#### 2.8.6 Steel Sheets

##### 2.8.6.1 Galvanized Steel

Galvanized steel shall be ASTM A 653/A 653M.

##### 2.8.6.2 Uncoated Steel

Uncoated steel shall be ASTM A 366/A 366M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

#### 2.8.7 Gaskets

Gaskets shall be nonasbestos material in accordance with ASME B16.21, full face or self-centering type. The gaskets shall be of the spiral wound type with graphite filler material.

#### 2.8.8 Steel Pipe and Fittings

##### 2.8.8.1 Steel Pipe

Steel pipe shall be ASTM A 53/A 53M, Type E or S, Grade A or B, black steel, standard weight.

##### 2.8.8.2 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

##### 2.8.8.3 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

##### 2.8.8.4 Welded Fittings

Welded fittings shall conform to ASTM A 234/A 234M with WPA marking. Buttwelded fittings shall conform to ASME B16.9, and socket-welded fittings shall conform to ASME B16.11.

##### 2.8.8.5 Cast-Iron Fittings

Fittings shall be ASME B16.4, Class 125, type required to match connecting piping.

##### 2.8.8.6 Malleable-Iron Fittings

Fittings shall be ASME B16.3, type as required to match connecting piping.

##### 2.8.8.7 Unions

Unions shall be ASME B16.39, Class 150.

##### 2.8.8.8 Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.8.9 Copper Tubing and Fittings

##### 2.8.9.1 Copper Tubing

Tubing shall be ASTM B 88, ASTM B 88M, Type K or L. Adapters for copper tubing shall be brass or bronze for brazed fittings.

##### 2.8.9.2 Solder-Joint Pressure Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and ASTM B 828.

#### 2.8.9.3 Flared Fittings

Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62.

#### 2.8.9.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

#### 2.8.9.5 Threaded Fittings

Cast bronze threaded fittings shall conform to ASME B16.15.

#### 2.8.9.6 Brazing Material

Brazing material shall conform to AWS A5.8.

#### 2.8.9.7 Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

#### 2.8.9.8 Solder Material

Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

#### 2.8.9.9 Solder Flux

Flux shall be either liquid or paste form, non-corrosive and conform to ASTM B 813.

#### 2.8.10 Dielectric Waterways and Flanges

Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways.

#### 2.8.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, and temperature

medium. The flexible section shall be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.8.12 Pipe Supports

Pipe supports shall conform to MSS SP-58 and MSS SP-69.

#### 2.8.13 Pipe Expansion

##### 2.8.13.1 Expansion Loops

Expansion loops and offsets shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops and offsets shall be cold-sprung and installed where indicated. Pipe guides and anchors shall be provided as indicated.

##### 2.8.13.2 Expansion Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the transverse indicated. The joints shall be designed for a hot water working pressure not less than 125 psig and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connection shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Sliding surfaces and water wetted surfaces shall be chromium plated or fabricated of corrosion resistant steel. Initial setting shall be made in accordance with the manufacturer's recommendations to compensate for an ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall not be more than 5 feet from expansion joint, except in lines 4 inches or smaller guides shall be installed not more than 2 feet from the joint. Service outlets shall be provided where indicated.

- a. Bellows-type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows-type expansion joints shall conform to the applicable requirements of EJMA Stds and ASME B31.1 with internal lines. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but shall not be less than 150 psig.
- b. Flexible ball joints shall be constructed of alloys as appropriate for the service intended. The joints shall be threaded, grooved, flanged, or welded end as required and shall be capable of absorbing the normal operating axial, lateral, or angular movements or combination thereof. Balls and sockets shall be polished, chromium-plated when materials are not of corrosion-resistant steel. The ball type joint shall be designed and constructed in accordance with ASME B31.1 and EJMA Stds. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets shall be suitable for the service intended.

- c. Slip type expansion joints shall be EJMA Stds and ASME B31.1, Class 1 or 2. Type II joints shall be suitable for repacking under full line pressure.

#### 2.8.14 Valves

Valves shall be Class 125 and shall be suitable for the application. Grooved ends per AWWA C606 may be used for water service only. Valves in nonboiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves shall match the same type of connection required for the piping on which installed.

##### 2.8.14.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

##### 2.8.14.2 Globe Valves

Globe valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

##### 2.8.14.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

##### 2.8.14.4 Angle Valves

Angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 3 inches and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

##### 2.8.14.5 Ball Valves

Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110, ductile iron or bronze, threaded, soldered, or flanged ends.

##### 2.8.14.6 Plug Valves

Plug valves 2 in. and larger shall conform to MSS SP-78. Plug valves smaller than 2 in. shall conform to ASME B16.34.

##### 2.8.14.7 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register the degree of valve opening. Valves shall be calibrated so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall

be supplied with preformed insulation. Valves shall be suitable for 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves, and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing.

#### 2.8.14.8 Automatic Flow Control Valves

In lieu of the specified balancing valves, automatic flow control valves may be provided to maintain constant flow and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 125 psi or 150 percent of the system operating pressure, whichever is greater. Where the available system pressure is not adequate to provide the minimum pressure differential that still allows flow control, the system pump head capability shall be increased. Valves shall be suitable for 250 degrees F temperature service. Valve materials shall be same as specified for the heating system check, globe, angle, and gate valves. Valve operator shall be the electric motor type or pneumatic type as applicable. Valve operator shall be capable of positive shutoff against the system pump head. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter shall be provided with accessory kit as recommended for the project by the automatic valve manufacturer.

#### 2.8.14.9 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 150 psig. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 8 inches shall have throttling handles with a minimum of seven locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

#### 2.8.14.10 Drain valves

Drain valves shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME BPV IV and ASTM A 53/A 53M.

#### 2.8.14.11 Safety Valves

Safety valves shall have steel bodies and shall be equipped with

corrosion-resistant trim and valve seats. The valves shall be properly guided and shall be positive closing so that no leakage can occur. Adjustment of the desired back-pressure shall cover the range between 2 and 10 psig. The adjustment shall be made externally, and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Boiler safety valves of proper size and of the required number, in accordance with ASME BPV IV, shall be installed so that the discharge will be through piping extended to a location as indicated or the nearest floor drain. Each discharge pipe for hot water service shall be pitched away from the valve seat.

#### 2.8.15 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and tapped with a gate valve attached for blowdown purposes. Strainers shall be designed for 125 psig service and 250 degrees F. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment screen. The screen shall be made of 22 gauge corrosion-resistant steel with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

#### 2.8.16 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shutoff valve. Minimum dial size shall be 3-1/2 inches. A pressure gauge shall be provided for each boiler in a visible location on the boiler. Pressure gauges shall be provided with readings in Kpa and psi. Pressure gauges shall have an indicating pressure range that is related to the operating pressure of the fluid in accordance with the following table:

Operating Pressure (kPa)	Pressure Range (kPa)
519-1030	0-1400
105-518	0-690
14-104	0-210 (retard)
Operating Pressure (psi)	Pressure Range (psi)
76-150	0-200
16-75	0-100
2-15	0-30 (retard)

#### 2.8.17 Thermometers

Thermometers shall be provided with wells and separable corrosion-resistant steel sockets. Thermometers for inlet water and outlet water for each hot water boiler shall be provided in a visible location on the boiler. Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 9 inch scale. The operating range of the thermometers shall be 0-100 degrees centigrade (32 - 212 degrees Fahrenheit). The thermometers shall be provided with readings in degrees centigrade and Fahrenheit.

## 2.8.18 Air Vents

### 2.8.18.1 Manual Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

### 2.8.18.2 Automatic Air Vents

Automatic air vents shall be 3/4 inch quick-venting float and vacuum air valves. Each air vent valve shall have a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. The name of the manufacturer shall be clearly stamped on the outside of each valve. The air vent valve shall be suitable for the pressure rating of the piping system.

## 2.9 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Motors which are not an integral part of a packaged boiler shall be rated for high efficiency service. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

### 2.9.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 hp and larger shall be three-phase, unless otherwise indicated. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

### 2.9.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function. Solid state variable speed controllers shall be utilized for fractional through 10 hp ratings. Adjustable frequency drives shall be used for larger motors.

## 2.10 INSULATION

Shop and field-applied insulation shall be as specified in Section 15080

## THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.11 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment.

Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

## 2.11.1 Breeching Cleaner

A cleaner shall be provided to clean the breeching. The cleaner shall have a jointed handle of sufficient length to clean the breeching without dismantling.

## 2.11.2 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation shall be provided. Tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

## 2.11.3 Wrenches

Wrenches shall be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets shall be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets shall be packaged and properly identified.

## 2.12 BOILER WATER TREATMENT

The water treatment system shall be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

## 2.12.1 MakeUp Water Analysis

The contractor shall conduct water testing

Date of Sample	
Temperature	degrees F
Silica (SiO <sub>2</sub> )	ppm (mg/l)

Insoluble	ppm (mg/1)
Iron and Aluminum Oxides	ppm (mg/1)
Calcium (Ca)	ppm (mg/1)
Magnesium (Mg)	ppm (mg/1)
Sodium and Potassium (Na and K)	ppm (mg/1)
Carbonate (HCO3)	ppm (mg/1)
Sulfate (SO4)	ppm (mg/1)
Chloride (Cl)	ppm (mg/1)
Nitrate (NO3)	ppm (mg/1)
Turbidity	unit
pH	
Residual Chlorine	ppm (mg/1)
Total Alkalinity	epm (meq/1)
Noncarbonate Hardness	epm (meq/1)
Total Hardness	epm (meq/1)
Dissolved Solids	ppm (mg/1)
Fluorine	ppm (mg/1)
Conductivity	micro-mho/cm

#### 2.12.2 Boiler Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits.

#### 2.12.3 Tanks

The tanks shall be constructed of high density polyethylene or stainless steel with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

#### 2.12.4 Injection Assemblies

An injection assembly shall be provided at each chemical injection point located along the boiler piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the water line.

#### 2.12.5 Water Meter

The water meter shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the makeup water line, as indicated.

#### 2.12.6 Water Treatment Control Panel

The control panel shall be a NEMA 12, single door, wall-mounted box conforming with NEMA 250. The panel shall be constructed of steel with a hinged door and lock. The panel shall contain, as a minimum, the following functions identified with a laminated plastic nameplate:

- a. Main power switch and indicating light
- b. MAN-OFF-AUTO selector switch
- c. Indicating lamp for blow down

- d. Indicating lamp for each chemical feed pump
- e. Indicating lamp for the water softener

#### 2.12.7 Sequence of Operation

The flow rate of chemical addition shall be based upon metering the makeup water. The boiler shall be provided with automatic blowdown based upon conductivity or boiler load. The required rate of chemical feed and boiler blowdown shall be determined by the water treatment company.

#### 2.12.8 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

#### 2.12.9 Chemical Piping

The piping and fittings shall be constructed of schedule 80 PVC.

#### 2.12.10 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

### PART 3 EXECUTION

#### 3.1 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Proper provision shall be made for expansion and contraction between boiler foundation and floor. This joint shall be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 100 degrees F. Boilers and firing equipment shall be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

#### 3.2 PIPING INSTALLATION

Unless otherwise specified, nonboiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe installed shall be cut accurately to suit field conditions, shall be installed without springing or forcing, and shall properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall be free of burrs, oil, grease and other foreign material and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through

the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unless otherwise specified or shown, final connections to equipment shall be made with malleable-iron unions for steel pipe 2-1/2 inches or less in diameter and with flanges for pipe 3 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines, reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

### 3.2.1 Hot Water Piping and Fittings

Pipe shall be black steel or copper tubing. Fittings for steel piping shall be black malleable iron or cast iron to suit piping. Fittings adjacent to valves shall suit valve material.

### 3.2.2 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

### 3.2.3 Gauge Piping

Piping shall be copper tubing.

### 3.2.4 Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 1 inch and smaller shall be threaded; fittings 1-1/4 inches and up to but not including 3 inches shall be either threaded, grooved, or welded; and fittings 3 inches and larger shall be either flanged, grooved, or welded. Pipe and fittings 1-1/4 inches and larger installed in inaccessible conduit or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable-iron unions for pipe 2-1/2 inches or smaller in diameter and with flanges for pipe 3 inches or larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

#### 3.2.4.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.

#### 3.2.4.2 Welded Joints

Welded joints shall be in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet

fittings, where used, shall be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Socket weld joints shall be assembled so that the space between the end of the pipe and the bottom of the socket is no less than 1/16 inch and no more than 1/8 inch.

#### 3.2.4.3 Flared and Brazed Copper Pipe and Tubing

Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Flared or brazed copper tubing to pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing.

#### 3.2.4.4 Soldered Joints

Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook.

#### 3.2.4.5 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

#### 3.2.5 Flanges and Unions

Flanges shall be faced true, provided with 1/16 inch thick gaskets, and made square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, they shall be provided with flat faces and full face gaskets. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the

galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

### 3.2.6 Branch Connections

#### 3.2.6.1 Branch Connections for Hot Water Systems

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 1 inch in 10 feet. When indicated, special flow fittings shall be installed on the mains to bypass portions of the water through each radiator. Special flow fittings shall be standard catalog products and shall be installed as recommended by the manufacturer.

#### 3.2.7 Flared, Brazed, and Soldered Copper Pipe and Tubing

Copper tubing shall be flared, brazed, or soldered. Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing. Brazed joints shall be made in conformance with MSS SP-73, and CDA Tube Handbook. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux.

Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Soldered joints shall be made with flux and are only acceptable for lines 2 inches or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA Tube Handbook.

#### 3.2.8 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

#### 3.2.9 Supports

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by

variable spring hangers and supports or by constant support hangers. Threaded rods which are used for support shall not be formed or bent.

#### 3.2.9.1 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.
- h. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.
- i. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
  - (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.
  - (2) Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is

greater.

- j. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.
- k. Piping in trenches shall be supported as indicated.
- l. Structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

#### 3.2.9.2 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support member shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. The clips or clamps shall be rigidly attached to the common base member. A clearance of 1/8 inch shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

#### 3.2.10 Anchors

Anchors shall be provided where necessary to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

#### 3.2.11 Valves

Valves shall be installed where indicated, specified, and required for functioning and servicing of the systems. Valves shall be safely accessible. Swing check valves shall be installed upright in horizontal lines and in vertical lines only when flow is in the upward direction. Gate and globe valves shall be installed with stems horizontal or above. Valves to be brazed shall be disassembled prior to brazing and all packing removed. After brazing, the valves shall be allowed to cool before reassembling.

#### 3.2.12 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof. Sleeves through walls shall be cut flush with wall surface. Sleeves through floors shall extend above top surface of floor a sufficient distance to allow proper flashing or finishing. Sleeves through roofs shall extend above the top surface of roof at least 6

inches for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls, and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

- a. Metal jackets shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.016 inch thick aluminum, if smooth.
- b. Metal jackets shall be secured with aluminum or stainless steel bands not less than 3/8 inch wide and not more than 8 inches apart. When penetrating roofs and before fitting the metal jacket into place, a 1/2 inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 36 inches above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the back-up material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above the floor; when passing through walls above grade, the jacket shall extend at least 4 inches beyond each side of the wall.

#### 3.2.12.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 4 pound lead flashing or a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than inches from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 10 inches. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 10 inches in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

#### 3.2.12.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts,

and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

#### 3.2.12.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 6 inches in diameter, lead flashing sleeve for dry vents with the sleeve turned down into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

#### 3.2.12.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

#### 3.2.13 Balancing Valves

Balancing valves shall be installed as indicated.

#### 3.2.14 Thermometer Wells

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

#### 3.2.15 Air Vents

Air vents shall be installed where shown or directed. Air vents shall be installed in piping at all system high points. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

#### 3.2.16 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrews.

#### 3.2.17 Drains

A drain connection with a 1 inch gate valve or 3/4 inch hose bib shall be installed at the lowest point in the return main near the boiler. In addition, threaded drain connections with threaded cap or plug shall be installed on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

#### 3.2.18 Strainer Blow-Down Piping

Strainer blow-down connections shall be fitted with a black steel blow-down pipeline routed to an accessible location and provided with a blow-down valve.

### 3.3 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15190 GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL Gas&Oil Dir. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

### 3.4 COLOR CODE MARKING AND FIELD PAINTING

Color code marking of piping shall be as specified in Section 09900 PAINTING GENERAL. Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09900 PAINTING, GENERAL. Exposed pipe covering shall be painted as specified in Section 09900 PAINTING, GENERAL. Aluminum sheath over insulation shall not be painted.

### 3.5 TEST OF BACKFLOW PREVENTION ASSEMBLIES

Backflow prevention assemblies shall be tested in accordance with Section 15400, PLUMBING, GENERAL PURPOSE.

### 3.6 HEATING SYSTEM TESTS

Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1-1/2 times the design working pressure, but not less than 100 psi. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested. Repair joints shall not be allowed under the floor for floor radiant heating systems. If a leak occurs in tubing located under the floor in radiant heating systems, the entire zone that is leaking shall be replaced. If any repair is made above the floor for floor radiant heating systems, access shall be provided for the installed joint. Caulking of joints shall not be permitted. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested. Upon completion of hydrostatic tests and before acceptance of the installation, the Contractor shall balance the heating system in accordance with Section

15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS; and operating tests required to demonstrate satisfactory functional and operational efficiency shall be performed. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

- a. Certification of balancing.
- b. Time, date, and duration of test.
- c. Outside and inside dry bulb temperatures.
- d. Temperature of hot water supply leaving boiler.
- e. Temperature of heating return water from system at boiler inlet.
- f. Quantity of water feed to boiler.
- g. Boiler make, type, serial number, design pressure, and rated capacity.
- h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.
- i. Circulating pump make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.
- j. Flue-gas temperature at boiler outlet.
- k. Percent carbon dioxide in flue-gas.
- l. Grade or type and calorific value of fuel.
- m. Draft at boiler flue-gas exit.
- n. Draft or pressure in furnace.
- o. Quantity of water circulated.
- p. Quantity of fuel consumed.
- q. Stack emission pollutants concentration.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. The Contractor shall furnish all instruments, equipment, and personnel required for the tests and balancing. Fuels, water, and electricity shall be obtained as specified in the SPECIAL CONTRACT REQUIREMENTS. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the requirements of ASME CSD-1

### 3.6.1 Water Treatment Testing

#### 3.6.1.1 Water Quality Test

The boiler water shall be analyzed prior to the acceptance of the facility by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	
Temperature	degrees F
Silica (SiO <sub>2</sub> )	ppm (mg/l)
Insoluble	ppm (mg/l)
Iron and Aluminum Oxides	ppm (mg/l)
Calcium (Ca)	ppm (mg/l)
Magnesium (Mg)	ppm (mg/l)
Sodium and Potassium (Na and K)	ppm (mg/l)
Carbonate (HCO <sub>3</sub> )	ppm (mg/l)
Sulfate (SO <sub>4</sub> )	ppm (mg/l)
Chloride (Cl)	ppm (mg/l)
Nitrate (NO <sub>3</sub> )	ppm (mg/l)
Turbidity	unit
pH	
Residual Chlorine	ppm (mg/l)
Total Alkalinity	epm (meq/l)
Noncarbonate Hardness	epm (meq/l)
Total Hardness	epm (meq/l)
Dissolved Solids	ppm (mg/l)
Fluorine	ppm (mg/l)
Conductivity	micro-mho/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

#### 3.6.1.2 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler and condensate piping shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations. If corrosion is found within the condensate piping, proper repairs shall be made by the water treatment company.

### 3.7 CLEANING

#### 3.7.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of either 1 pound of caustic soda or 1 pound of trisodium phosphate per 50 gallons of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 150 degrees F and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

#### 3.7.2 Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots

removed. Temporary filters shall be provided for fans that are operated during construction, and new filters shall be installed after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.8 FIELD TRAINING

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance instructions, as well as demonstrations of routine maintenance operations and boiler safety devices. The Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

-- End of Section --

## SECTION 15601

## CENTRAL REFRIGERATION EQUIPMENT FOR AIR CONDITIONING

**09/99**

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 590 (1992) Positive Displacement Compressor  
Water-Chilling Packages

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING  
ENGINEERS, INC. (ASHRAE)

ASHRAE 15 (1994; Errata 1994) Safety Code for  
Mechanical Refrigeration

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME PTC 23 (1986; R 1997) Atmospheric Water Cooling  
Equipment

ASME BPVC SEC VIII (1995; Addenda 1995, 1996, and 1997) Boiler  
and Pressure Vessel Code: Section VIII  
Pressure Vessels

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (1997; Rev. A) Zinc (Hot-Dip Galvanized)  
Coatings on Iron and Steel Products

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM D 596 (1991; R 1995) Reporting Results of  
Analysis of Water

ASTM D 1654 (1992) Evaluation of Painted or Coated  
Specimens Subjected to Corrosive  
Environments

## COOLING TOWER INSTITUTE (CTI)

CTI ATC-105 (1997) Acceptance Test Code for  
Water-Cooling Towers

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ICS 2 (1993) Industrial Control and Systems  
Controllers, Contactors and Overload

Relays, Rated Not more Than 2000 Volts AC  
or 750 Volts DC

NEMA MG 1 (1993; Rev. 1-4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1998) National Electrical Code

UNDERWRITERS LABORATORIES INC. (UL)

UL 465 (1982; R 1996, Bul. 1997) Central Cooling  
Air Conditioners

## 1.2 RELATED REQUIREMENTS

Section 15050N, "Basic Mechanical Materials and Methods," applies to this section with the additions and modifications specified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01330, "Submittal Procedures."

### SD-02 Shop Drawings

Water chillers G, AE.

### SD-03 Product Data

Water chillers G, AE.

Electric motors and starters G, AE.

### SD-06 Test Reports

Start-up and initial operational tests G, AE

### SD-10 Operation and Maintenance Data

Water Chillers Data Package 3

Electric motors and starters Data Package 3

Submit operation and maintenance data in accordance with Section 01781N, "Operation and Maintenance Data."

## 1.4 QUALITY ASSURANCE

### 1.4.1 Modifications of References

In the referenced publications, the advisory provisions shall be mandatory; substitute the word "shall" for "should" or "it is recommended" wherever they appear; reference to the "authority having jurisdiction" and "owner"

shall be interpreted to mean the Contracting Officer.

#### 1.4.2 Pressure Vessels

Design, fabrication, inspection, and testing of pressure vessels including waterside and refrigerant side of condensers and liquid coolers (evaporators) shall be in accordance with ASME BPVC SEC VIII and ASHRAE 15.

The ASME official Code U-Symbol or Code UM-Symbol stamped or marked on the vessels, and the submission of the applicable ASME required manufacturer's data report will be accepted as evidence that pressure vessels comply to ASME rules for construction. Submit results of pressure vessel tests. Provide make-up water analysis in accordance with ASTM D 596.

#### 1.4.3 Personnel Protection

UL 465. Provide personnel protection from moving parts including fans, pulleys, chains, gears, and couplings. High temperature machinery and piping shall be guarded or covered with insulation.

#### 1.4.4 Electrical Systems

Wiring and components shall conform to NFPA 70 and UL 465.

#### 1.5 CENTRAL REFRIGERATION EQUIPMENT

Provide manufacturer's instruction, including evacuation and charging procedures and posted operating instructions for each piece of refrigeration equipment.

#### 1.6 REFRIGERANTS AND OILS

Dehydrate, purge, and charge refrigerant circuit with refrigerant and oil at factory. Factory oil and refrigerant charge shall be full amount required for operation, if within limits permitted by the Department of Transportation; otherwise, a holding charge shall be furnished. Field charging, where only a holding charge is shipped, shall be accomplished without breaking permanent refrigerant connections. Furnish one complete charge of lubricating oil in sealed containers in addition to that placed in system. Chillers using R-11, R-12, R-113, R-114, R-115, or R-500 as a refrigerant will not be permitted. Refrigerants shall have an Ozone Depletion Factor (ODF) of 0.05 or less. The ODF shall be in accordance with the "Montreal Protocol On Substances That Deplete The Ozone Layer," September 1987, sponsored by the United Nations Environment Programme.

### PART 2 PRODUCTS

#### 2.1 SELF-CONTAINED WATER CHILLERS

Provide complete, packaged water chillers, each mounted on a single welded-steel base. Chillers shall be ready for operation after installation and field testing. Equipment shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, shall have lifting eyes or lugs. Provide insulation for surfaces subject to sweating including the liquid cooler, suction line piping, water boxes, economizer, and cooling lines. Insulation shall conform to Section 15080, "Mechanical Insulation."

### 2.1.1 Reciprocating, Helical Rotary, Scroll, Air-Cooled

ARI 590. Base capacity and power ratings, at the conditions indicated and specified, on the test requirements of ARI 590. Power input shall not exceed 1.4 kW/ton load at full load capacity. For multicompressor units, not less than two independent refrigerant circuits shall be provided. Chillers shall be capable of operating at partial-load conditions without increased vibration over normal vibration at full load operation, and shall be capable of continuous operation down to minimum capacity.

#### 2.1.1.1 Casings

Aluminum not less than 0.040 inch in nominal thickness or steel not lighter than 18 gage ( 0.0516 inch) in nominal thickness. Provide condensers having horizontal air discharge with discharge baffles to direct air upward, constructed of same material and thickness as casing. Provide wire screens or louvers over exposed condenser coil fins not protected by casing.

#### 2.1.1.2 Reciprocating Compressors

Provide with forced-feed lubrication, crankcase heater, hot-gas muffler and suction strainer. Cylinder unloading devices shall be unloaded when compressor starts. Piston speed for open compressors shall not exceed recommendations of manufacturer or 1000 feet per minute (fpm), whichever is less.

#### 2.1.1.3 Helical Rotary Compressors

Positive displacement, oil injected type, and driven by an electric motor. Rotors shall be solid steel, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbitt; or frictionless bearing design, ball or roller type. Housings and covers shall be high-grade cast-iron pressure castings. Lubrication systems shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when oil management system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electric power supply.

#### 2.1.1.4 Scroll Compressors

Three-dimensional, compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Main bearings shall be rolling-element type. Lubrication systems shall be centrifugal pump type including oil level sight glass and oil charging valve.

#### 2.1.1.5 Condenser Coils

Extended-surface fin-and-tube type. Condenser coils shall be constructed of copper tubes and aluminum fins or copper tubes and copper fins . Fins shall be hydraulically or mechanically bonded to tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity.

#### 2.1.1.6 Fans

Statically and dynamically balanced. For V-belt drive fans, provide adjustable sheaves. Provide fans with vibration isolation devices to

minimize vibration transmission.

#### 2.1.1.7 Liquid Coolers (Evaporators)

Tubes shall be seamless copper. Refrigerant side design pressure shall comply with ASHRAE 15. Water side design pressure shall not be less than 150 psig. On direct-expansion units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum capacity. For the water side of liquid cooler, the performance shall be based on a water velocity ranging from 3 to 12 fps with a fouling factor of 0.00025.

#### 2.1.1.8 Controls, Control Panels, and Gages

Provide a control panel fitted with a discharge pressure gage, suction pressure gage, separate high pressure cutout with manual reset, separate low pressure cutout, low water temperature cutout with manual reset, compressor operating control, and manual off-auto switch. Provide oil pressure gage and low-oil-pressure cutout switch with manual reset for chillers with positive displacement type oil pumps. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Multicompressor units shall be provided with a lead/lag selector switch. Provide a timer to prevent compressors from short cycling whenever stopped by safety controls. Time delay shall be not less than 5 minutes. A pumpdown cycle of the nonrecycling start type shall be provided for each compressor 20 tons or larger. Provide a minimum 4 inch alarm bell and alarm bell circuit to actuate bell in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Provide system capacity control to adjust chiller output to a minimum of 25 percent of full load capacity without cycling operating compressor and to automatically recycle system on power interruption. Provide start-up and head pressure controls to allow for system operation at all ambient temperatures down to 25 degrees F.

#### 2.1.1.9 Electric Motors and Starters

Provide induction electrical motors conforming to NEMA MG 1. Fan motor bearings shall be permanently lubricated. Compressor starters shall be reduced-voltage type conforming with NEMA ICS 1 and NEMA ICS 2. Provide phase failure, over voltage and low voltage protection.

### 2.2 FINISHES

Steel surfaces of equipment including reciprocating, helical rotary, scroll, air cooled water chillers, that do not have a zinc coating conforming to ASTM A 123/A 123M, or a duplex coating of zinc and paint, shall be provided with a factory applied coating or paint system. Thickness of coating or paint system on the actual equipment shall be identical to that on the salt-spray test specimens with respect to materials, conditions of application, and dry film thickness.

### 2.3 SOURCE QUALITY CONTROL

#### 2.3.1 Salt-Spray Tests

Factory-applied coating or paint system on equipment located outdoors including reciprocating, helical rotary, scroll, air-cooled water chillers, and air-cooled remote-type condensers, shall be factory salt-spray tested in accordance with ASTM B 117. Period of test shall be 500 hours. Test

specimens shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. Rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). Rating of the unscribed area shall not be less than 10 (no failure).

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Installation procedures shall conform to ASHRAE 15, and manufacturer's recommendations. Refrigerant safety relief devices shall have discharge piped to building exterior. Interlock compressor operation with the chilled water pump starters, so that compressors cannot operate unless the pumps are operating. Make piping connections to equipment after piping systems have been tested and cleaned.

##### 3.1.1 AUTOMATIC GLYCOL MAKE-UP SYSTEM

Automatic Glycol Make-up shall function to automatically inject a glycol/water solution into the cooling loop based on the pressure requirements of the loop. The system shall consist of a structural steel frame fabricated to AISC specifications, a polyethylene storage tank having a minimum wall thickness of 1/4" with lid, and transfer pump. Required instrumentation and valves shall be provided with a NEMA 12 Control Panel to accomplish automatic operation of the system. The system shall be factory set to operate at a minimum system pressure of 12 psig. The minimum operating pressure shall be field adjustable. One coat of high-grade machinery enamel shall be furnished on all ferrous surfaces. The system shall be designed to allow for ease of field modification and maintenance. A common system frame and transfer pump shall be used in all systems. The frame shall be capable of accepting a 55 gallon solution tank. System shall use a transfer pump capable of pumping 2.75 gpm of pgm of glycol/water solution at a pressure of 200TDH. The pump/motor shall be close coupled, ODP, and shall be 1/3 HP maximum. All system components shall be designed to operate on 120 volt, 60 hertz power. Discharge piping shall be schedule 40 carbon steel with threaded MI fittings. Suction piping shall include the use of flexible hose with intergral Y strainer. Valves shall be furnished to permit the system and system components to be isolated from the heating/cooling loop. A pressure relief valve shall be furnished and piped back to the colution tank. The system connection furnished shall be 1/2 FNPT. Contrtols shall be provided to de-energize the system in the event of low solution level or a high discharge pressure. In the event of an alarm condition, a red alarm light and an audible alarm shall be energixed. All alarms shall be manually reset. A dry contact shall be provided for remote alarm indication. The system shall be designed to operate on 120 volt, 60 hertz power. A test certificate shall be furnisheed stating that the system has been pressure tested and electrically function tested at the factory prior to shipment.

#### 3.2 FOUNDATIONS

Foundations for mounting of equipment, accessories, appurtenances, piping, and controls shall be provided, including supports, vibration isolators, stands, guides, anchors, clamps, and brackets. Anchor bolts and sleeves shall be set using templates. Anchor bolts shall be provided with welded-on plates on the head end embedded in the concrete. Equipment bases

shall be leveled, using jacks or steel wedges, and grouted in using a nonshrinking type of grouting mortar. Foundations shall conform to manufacturer's recommendations.

### 3.3 LOCATIONS AND CLEARANCES

Equipment shall be located so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide manufacturer's recommended clearances for installation, operation, and maintenance, for cooling towers and chillers located within enclosures.

### 3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use. Plates and tags shall be brass or nonferrous material. Minimum letter and numeral sizes shall be 1/8 inch high.

### 3.5 FIELD QUALITY CONTROL

Perform tests and provide labor, materials, and equipment required. Notify the Contracting Officer, in writing, 10 days before performing tests. Tests shall be performed in the presence of a manufacturer's representative. Tests shall conform to Section 15950N, "HVAC "Testing/Adjusting/Balancing."

#### 3.5.1 Start-Up and Initial Operational Tests

Provide chemicals and place water treatment systems in operation before initial start-up. Equipment shall be started and operated. Follow manufacturer's procedures and place systems under all modes of operation. Initial charges of refrigerant lubricating oil shall be supplemented to ensure maximum operating capacity. Safety and automatic control instruments shall be adjusted. Record manufacturer's recommended readings hourly. Operational tests shall cover a period of not less than 3 days.

#### 3.5.2 [Enter Appropriate Subpart Title Here]

##### 3.5.2.1 Air Temperatures

Take air temperatures by mechanically aspirated psychrometers, and in accordance with ASME PTC 23. Temperatures shall be used as ambient conditions. When using CTI procedure, temperature measurements shall be in accordance with CTI ATC-105.

##### 3.5.2.2 Thermometers

Provide to read air and water temperatures simultaneously. Immediately prior to tests, calibrate thermometers by simultaneous immersion in hot well, or other mutually agreed upon method, and note correction factors and points of utilization for each thermometer together with its serial number.

##### 3.5.2.3 Laboratory Test Results

Submit computations together with six complete sets of test results. Computations and test results shall be presented in full compliance with particular test procedure employed by testing agency.

### 3.5.3 Manufacturer's Field Services

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturer's representatives shall furnish advice and services on the following matters:

- a. Erection, alignment, testing and dehydrating;
- b. Testing hermetic equipment under pressure for leaks, and evacuation and dehydration of machine to 35 degrees F wet bulb or an absolute pressure of not over 0.204 inch of mercury;
- c. Charging equipment with refrigerant and oil; and
- d. Starting equipment and training Government personnel on equipment care, operation, and maintenance.

-- End of Section --

## SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM  
02/94

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1989) Central-Station Air-Handling Units
ARI 880	(1998) Air Terminals
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

## AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4	(1990) Installation Techniques for Perimeter Heating & Cooling; 11th Edition
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## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

## AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123/A 123M	(1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 924/A 924M	(1999) General Requirements for Steel

	Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1995e1) Zinc Dust Pigment
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)	
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 68	(1986) Laboratory Method of Testing In-Duct Sound Power Measurement Procedures for Fans
ASHRAE 70	(1991) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASME INTERNATIONAL (ASME)	
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA MG 1	(1998) Motors and Generators
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems
NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)	
NAIMA AH115	(1993) Fibrous Glass Duct Construction

## Standards

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION  
(SMACNA)

SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

## UNDERWRITERS LABORATORIES (UL)

UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1999) Fire Dampers
UL 723	(1996; Rev thru Dec 1998) Test for Surface Burning Characteristics of Building Materials
UL 900	(1994; Rev thru Nov 1999) Test Performance of Air Filter Units
UL Bld Mat Dir	(1999) Building Materials Directory
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1999) Fire Resistance Directory (2 Vol.)

## 1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

## 1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G, AE

Installation; G, AE

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

#### SD-03 Product Data

Components and Equipment; G, AE

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

- a. Piping Components
- b. Ductwork Components
- c. Air Systems Equipment
- d. Air Handling Units
- f. Terminal Units

#### Test Procedures;

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

#### Welding Procedures;

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

#### System Diagrams; G, AE.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

#### Similar Services;

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

#### Welding Joints;

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

#### Testing, Adjusting and Balancing; G, AE.

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

#### Field Training;

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

### SD-06 Test Reports

#### Performance Tests; G,AE

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

### SD-10 Operation and Maintenance Data

#### Operating and Maintenance Instructions;

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4hour onsite response to a service call on an emergency basis.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is

offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

## 2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

## 2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

## 2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

## 2.5 PIPING COMPONENTS

### 2.5.1 Chilled Water System Accessories

Chilled water system accessories such as pumps, combination strainer and suction diffusers, and expansion tanks shall be as specified in Section 15569A WATER HEATING, GAS, up to 20 MBH.

### 2.5.2 Water Heating System Accessories

Water or steam heating accessories such as expansion tanks shall be as specified in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

### 2.5.3 Glycol

The glycol shall be tested according to ASTM D 1384 and shall cause less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicon based inhibitors shall not be used. The solution shall be compatible with all wetted items within the system.

### 2.5.4 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

### 2.5.5 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 125 psi or 150 psi service as appropriate for the static head plus the system head, and 250 degrees F, 230 degrees F for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end

connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.5.6 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter and shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure.

#### 2.5.7 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale, and shall have rigid stems with straight, angular, or inclined pattern.

#### 2.5.8 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

#### 2.5.9 Insulation

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.5.10 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400 PLUMBING, GENERAL PURPOSE.

### 2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

## 2.7 CONTROLS

Controls shall be provided as specified in Section 15951 DIRECT DIGITAL CONTROL FOR HVAC.

## 2.8 DUCTWORK COMPONENTS

### 2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap.

Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

#### 2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

#### 2.8.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply galvanized steel or two-ply aluminum. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 15 inches water gauge at 350 degrees F when duct is aluminum, and 650 degrees F when duct is galvanized steel or stainless steel.

#### 2.8.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 10 feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition

piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

#### 2.8.1.4 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

#### 2.8.1.5 High Temperature Service Duct Connections

Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yardweight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

#### 2.8.2 Fibrous Glass Ductwork

Fibrous glass ductwork may be provided in lieu of sheet metal ductwork except that fibrous glass ductwork will not be allowed in fan and equipment rooms, where subject to traffic or weather damage, for outside air intakes, for risers of more than two stories, in kitchen or fume exhaust ducts, to convey solids or corrosive gases, in concrete, for burial below grade, as casings or housings, or in systems used for life support systems. Fibrous glass ductwork, including all components, shall be fabricated according to NAIMA AH115 where the velocity and the static pressure are within its scope. Where the velocity or static pressure exceeds these limits, the ductwork manufacturer shall certify that the ductwork is intended for the velocities and pressures to be encountered, and that the proposed installation meets all performance criteria specified herein for metal ductwork. Fibrous glass ductwork shall have the thermal equivalent of the insulation specified for metal ductwork in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Field or factory fabricated fibrous glass ductwork shall conform to UL 181, Class 1. Duct wall penetrations, transverse joints and longitudinal seams shall be sealed as instructed by the manufacturer by one of the methods prescribed by NAIMA AH115, where applicable, except that pressure sensitive tape shall not be used as a sealant. All items necessary for a complete installation shall be provided as specified for sheet metal duct systems.

#### 2.8.3 Ductwork Accessories

##### 2.8.3.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be

minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

#### 2.8.3.2 Fire Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. The Contractor shall perform the fire damper test as outlined in NFPA 90A. A pressure relief damper shall be provided upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then this pressure relief damper shall be factory insulated. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be curtain type with damper blades out of the air stream or multi-blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

#### 2.8.3.3 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 3/16 inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 12 inches. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

#### 2.8.3.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the

drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

#### 2.8.4 Duct Sleeves, Framed Prepared Openings, Closure Collars

##### 2.8.4.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53/A 53M, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

##### 2.8.4.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

##### 2.8.4.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch

centers, except that not less than 4 fasteners shall be used.

#### 2.8.5 Sound Attenuation Equipment

##### a. Systems With Total Pressure Above 4 Inches Water Gauge:

Sound attenuators shall be provided on the discharge duct of each fan operating at a total pressure above 4 inch water gauge, and, when indicated, at the intake of each fan system. Sound attenuators shall be provided elsewhere as indicated. The sound attenuators shall be factory fabricated and shall be tested by an independent laboratory for sound and performance characteristics. Net sound reduction shall be as indicated. Maximum permissible pressure drop shall not exceed 0.63 inch water gauge. Traps shall be constructed to be airtight when operating under an internal static pressure of 10 inch water gauge. Air-side surface shall be capable of withstanding air velocity of 10,000 fpm. The Contractor shall certify that the sound reduction values specified will be obtained after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system may be provided in lieu of factory fabricated sound attenuators, and shall comply with requirements specified for factory fabricated sound attenuators. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified. The Contractor shall certify that the sound reduction value specified will be obtained within the length of duct run provided. The outer sheet metal of the double-walled duct shall have welded, or spiral lock, seams to prevent water vapor penetration. The outer sheet of the duct and fittings shall conform to the metal thickness of high pressure spiral and round ducts and fittings shown in SMACNA HVAC Duct Const Stds. The acoustical insulation shall have a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. The internal perforated zinc-coated metal liner shall be not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

##### a. System With Total Pressure of 4 Inch Water Gauge and Lower:

Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 22 gauge. Acoustical fill shall be fibrous glass. Net sound reduction shall be as indicated. Values shall be obtained on a test unit not less than 24 inches by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when

operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

a. Acoustical Duct Liner:

Acoustically lined duct shall be provided for all ductwork within 20 feet of each AHU. Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and shall conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 1 inch thick. Where acoustical duct liner is used, liner or combination of liner and insulation applied to the exterior of the ductwork shall be the thermal equivalent of the insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used. Factory fabricated double-walled internally insulated duct with perforated liner may be provided. Net insertion loss value, static pressure drop, and air flow velocity capacity data shall be certified by a nationally recognized independent acoustical laboratory.

#### 2.8.6 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen according to NFPA 90A.

##### 2.8.6.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

##### 2.8.6.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar

in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

#### 2.8.7 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

#### 2.8.8 Air Vents, Penthouses, and Goosenecks

Air vents and penthouses, shall be fabricated from galvanized steel or aluminum sheets with galvanized or aluminum structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA HVAC Duct Const Stds. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

#### 2.8.9 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

### 2.9 AIR SYSTEMS EQUIPMENT

#### 2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 120 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts.

Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

### 2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 30 inches. Fan blades for wheels over 30 inches in diameter shall be backward-inclined or airfoil design. Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Manually operated outlet dampers shall be provided. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have open enclosures. Motor starters shall be magnetic across-the-line type with general-purpose enclosure. Remote manual switch with pilot indicating light shall be provided where indicated.

### 2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing.

Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Motors shall have open enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosures.

### 2.9.1.3 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by AFBMA Std 9 and AFBMA Std 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Fan unit shall be provided with inlet and outlet flanges, Unless otherwise indicated, motors shall not exceed 1800 rpm and shall have open

enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosure.

#### 2.9.1.4 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be dripproof type. Gravity backdraft dampers shall be provided where indicated.

#### 2.9.1.5 Centrifugal Type Power Roof Ventilators

Fans shall be direct or V-belt driven as scheduled with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with birdscreen, disconnect switch, gravity dampers, roof curb, and extended base. Motors enclosure shall be dripproof type. Lubricated bearings shall be provided.

#### 2.9.1.6 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be U.L. listed.

#### 2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper red brass tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.016 inches. Aluminum fins shall be 0.0055 inch minimum thickness. Copper fins shall be 0.0045 inch minimum thickness. Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 psi air pressure and shall be suitable for 200 psi working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

##### 2.9.2.1 Water Coils

Water coils shall be installed with a pitch of not less than 1/8 inch per foot of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

#### 2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900.

##### 2.9.3.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

## 2.10 AIR HANDLING UNITS

### 2.10.1 Factory-Fabricated Air Handling Units

Units shall be single-zone draw-through type or single-zone blow-through type as indicated. Units shall include fans, coils, airtight insulated casing, filter sections, and diadjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, mixing box vibration-isolators, and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

#### 2.10.1.1 Casings

Casing sections shall be 2 inch double wall type as indicated, constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. Inner casing of double-wall units shall be minimum 20 gauge solid galvanized steel. Casing shall be designed and constructed with an integral structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 18 gauge outer and 20 gauge inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 12 inches wide by 12 inches high. Access doors shall be minimum 24 inches wide and shall be the full height of the unit casing or a minimum of 6 ft., whichever is less. Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-bottom type constructed of 16 gauge galvanized steel, pitched to the drain connection. Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Each casing section handling conditioned air shall be insulated with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Factory applied fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Foam-type insulation is not acceptable. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors and casing sections. Duct liner material, coating, and adhesive shall conform to fire-hazard requirements specified in Section 15080 THERMAL INSULATION FOR MECHANICAL

SYSTEMS. Exposed insulation edges and joints where insulation panels are butted together shall be protected with a metal nosing strip or shall be coated to conform to meet erosion resistance requirements of ASTM C 1071. A latched and hinged inspection door, shall be provided in the fan and coil sections. Additional inspection doors, access doors and access sections shall be provided where indicated.

#### 2.10.1.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

#### 2.10.1.3 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

#### 2.10.1.4 Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Bearings may not be fastened directly to the unit sheet metal casing. Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have open enclosures. Motor starters shall be magnetic type with general-purpose enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300 or ASHRAE 68.

#### 2.10.1.5 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

#### 2.10.1.6 Dampers

Dampers shall be as specified in paragraph CONTROLS.

### 2.11 TERMINAL UNITS

#### 2.11.1 Variable Air Volume (VAV)

VAV terminal units shall be the type, size, and capacity shown and shall be mounted in the ceiling or wall cavity and shall be suitable for single duct system applications. Actuators and controls shall be as specified in paragraph CONTROLS. Unit enclosures shall be constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge.

Single or multiple discharge outlets shall be provided as required. Units with flow limiters are not acceptable. Unit air volume shall be factory preset and readily field adjustable without special tools. Reheat coils shall be provided as indicated. A flow chart shall be attached to each unit. Acoustic performance of the terminal units shall be based upon units tested according to ARI 880. Sound power level shall be as indicated. Discharge sound power shall be shown for minimum and and 1 inches water gauge inlet static pressure. Acoustical lining shall be according to NFPA 90A.

##### 2.11.1.1 Variable Volume, Single Duct

Variable volume, single duct, terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Units shall control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Internal resistance of units shall not exceed 0.4 inch water gauge at maximum flow range. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement with a 0 to 1 inch water gauge range.

##### 2.11.1.2 Variable Volume, Single Duct, Fan-Powered

Variable volume, single duct, fan-powered terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Units shall control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 3/4 to 6 inch water gauge. Unit fan shall be centrifugal, direct-driven, double-inlet type with forward curved blades. Fan motor shall be either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type. Fan/motor assembly shall be isolated from the casing to minimize vibration transmission. Fan control shall be factory furnished and wired into the unit control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

##### 2.11.1.3 Reheat Units

- a. Hot Water Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube

support sheets shall be 16 gauge, galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 250 psi air pressure and shall be suitable for 200 psi working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.

## 2.12 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

#### 3.1.1 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 6 inch concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.2 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels

shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

### 3.1.3 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

### 3.1.4 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

### 3.1.5 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

#### 3.1.5.1 Underground Ductwork

Underground ductwork shall be PVC plastisol coated galvanized steel with coating on interior and exterior surfaces and watertight joints. Ductwork shall be installed as indicated, according to ACCA Manual 4 and manufacturer's instructions. Maximum burial depth shall be 6 feet.

### 3.1.6 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA HVAC Duct Const Stds. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at

the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA HVAC Duct Const Stds to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

### 3.1.7 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

### 3.1.8 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated up to the point where the outdoor air reaches the conditioning unit.

### 3.1.9 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

### 3.1.10 Power Roof Ventilator Mounting

Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

### 3.1.11 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

## 3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

## 3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place

before covering or concealing.

### 3.4 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

### 3.5 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of air terminal units, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

### 3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 3 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

### 3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

## SECTION 15951

DIRECT DIGITAL CONTROL FOR HVAC  
06/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA Std 500 (11989; Rev994) Test Methods for Louvers, Dampers and Shutters

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 142 (1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ST 1 (1988) Specialty Transformers (Except General-Purpose Type)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 508 (1993; Rev thru Oct 1997) Industrial Control Equipment

## 1.2 GENERAL REQUIREMENTS

The direct digital control (DDC) shall be a complete system suitable for the heating, ventilating and air-conditioning (HVAC) system. The direct digital control (DDC) shall be a complete system suitable for the heating,

ventilating and air-conditioning (HVAC) system and shall connect to the existing LONMARK work station located in room 227 of the Base Civil Engineering Building.

#### 1.2.1 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

#### 1.2.2 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 1.2.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

#### 1.2.4 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected from power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

#### 1.2.5 Surge Protection for Transmitter and Control Wiring

DDC system control-panel equipment shall be protected against surges induced on control and transmitter wiring installed outside and as shown. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

a. A 10-microsecond by 1,000-microsecond waveform with a peak voltage of 1,500 volts and a peak current of 60 amperes.

b. An eight microsecond by 20-microsecond waveform with a peak voltage of 1,000 volts and a peak current of 500 amperes.

#### 1.2.6 System Overall Reliability Requirement

The system shall be configured and installed to yield a mean time between failure (MTBF) of at least 40,000 hours. Each DDC controller shall be designed, configured, installed and programmed to provide for stand alone operation with minimal performance degradation on failure of other system components to which it is connected or with which it communicates.

#### 1.2.7 DDC System Network Accessibility

Where the systems to be controlled by the DDC system are located in multiple mechanical rooms, each mechanical room shall have at least one

communication port for the portable workstation/tester. DDC controllers shall be located in the same room as the equipment being controlled or in an adjacent space which has direct access to the equipment room.

#### 1.2.8 System Accuracy and Display

The system shall maintain an end-to-end accuracy for one year from sensor to operator's console display for the applications specified and shall display the value as specified. Each temperature shall be displayed and printed to nearest 0.1 degree F.

##### 1.2.8.1 Space Temperature

Space temperature with a range of 50 to 85 degrees F plus or minus 0.75 degree F for conditioned space; 30 to 130 degrees F plus or minus 1 degree F for unconditioned space.

##### 1.2.8.2 Duct Temperature

Duct temperature with a range of 40 to 140 degrees F plus or minus 2 degrees F.

##### 1.2.8.3 Outside Air Temperature

Outside air (OA) temperature with a range of minus 30 to plus 130 degrees F plus or minus 2 degrees F; with a subrange of 30 to 100 degrees F plus or minus 1 degree F.

##### 1.2.8.4 Water Temperature

Water temperature with a range of 30 to 100 degrees F plus or minus 0.75 degree F; the range of 100 to 250 degrees F plus or minus 2 degrees F; and water temperatures for the purpose of performing Btu calculations using differential temperatures to plus or minus 0.5 degree F using matched sensors.

##### 1.2.8.5 High Temperature

High temperature with a range of 200 to 500 degrees F plus or minus 2.0 degrees F.

##### 1.2.8.6 Relative Humidity

Relative humidity, within a range of 20 to 80 percent, plus or minus 6.0 percent of range (display and print to nearest 1.0 percent).

##### 1.2.8.7 Pressure

Pressure with a range for the specific application plus or minus 2.0 percent of range (display and print to nearest psi.)

##### 1.2.8.8 Flow

Flow with a range for the specific application plus or minus 3.0 percent of range, and flows for the purpose of thermal calculations to plus or minus 2.0 percent of actual flow (display and print to nearest unit, such as gallons per minute).

##### 1.2.8.9 KWh and kW Demand

KWh and kW demand with a range for the specific application plus or minus 1.0 percent of reading (display and print to nearest kWh or kW).

#### 1.2.8.10 Analog Value Input

An analog value input to the system's equipment via an AI with a maximum error of 0.50 percent of range, not including the sensor or transmitter error. This accuracy shall be maintained over the specified environmental conditions.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

HVAC Control System; G, AE.

Drawings shall be on 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and identifiers shown. Each control system element on a drawing shall have a unique identifier as shown. The HVAC Control System Drawings shall be delivered together as a complete submittal. Deviations must be approved by the Contracting Officer. Drawings shall be submitted along with Submittal SD-01, Data.

a. HVAC Control System Drawings shall include the following:

Sheet One: Drawing Index, HVAC Control System Legend.

Sheet Two: Valve Schedule, Damper Schedule.

Sheet Three: Control System Schematic and Equipment Schedule.

Sheet Four: Sequence of Operation and Data Terminal Strip Layout.

Sheet Five: Motor Starter and Relay Wiring Diagram.

Sheet Six: Communication Network and Block Diagram.

Sheet Seven: DDC Panel Installation and Block Diagram.

(Repeat Sheets Four through Seven for each AHU System.)

b. The HVAC Control System Drawing Index shall show the name and number of the building, military site, State or other similar designation, and Country. The Drawing Index shall list HVAC Control System Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. The HVAC Control System Legend shall show generic symbols and the name of devices shown on the HVAC Control System Drawings.

c. The valve schedule shall include each valve's unique identifier, size, flow coefficient Cv, pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data. Valve schedules may be submitted in advance but shall be included in the complete submittal.

d. The damper schedule shall contain each damper's and each actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule shall include the maximum leakage rate at the operating static-pressure differential. The Damper Schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements. Damper schedules may be submitted in advance but shall be included in the complete submittal.

f. The HVAC control system schematics shall be in the form shown, and shall show all control and mechanical devices associated with the HVAC system. A system schematic drawing shall be submitted for each HVAC system.

g. The HVAC control system equipment Schedule shall be in the form shown. All devices shown on the drawings having unique identifiers shall be referenced in the equipment schedule. Information to be included in the equipment schedule shall be the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e., output range). An equipment schedule shall be submitted for each HVAC system.

h. The HVAC control system sequence of operation shall reflect the language and format of this specification, and shall refer to the devices by their unique identifiers as shown. No operational deviations from specified sequences will be permitted without prior written approval of the Contracting Officer. Sequences of operation shall be submitted for each HVAC control system including each type of terminal unit control system.

i. The HVAC control system wiring diagrams shall be functional wiring diagrams which show the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged equipment control systems shall be identified back to the panel board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown. Wiring diagrams shall be submitted for each HVAC control system.

Service Organizations; G, AE.

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

Equipment Compliance Booklet; G, RE.

The HVAC Control System Equipment Compliance Booklet (ECB) shall be in booklet form and indexed, with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a Bill of Materials for each HVAC Control System. The Bill of Materials shall function as the Table of Contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB. The ECB shall be submitted along with Submittal SD-04, Drawings.

Commissioning Procedures; G, AE.

Six copies of the HVAC control system commissioning procedures, in booklet form and indexed, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal unit control system. The Commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The Commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

a. The Commissioning procedures shall include detailed, product specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

b. An HVAC control system commissioning procedures equipment list shall be included that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Performance Verification Test Procedures; G, RE.

Six copies of the HVAC Control System Performance Verification Test Procedures, in booklet form and indexed, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique

identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation, and other contract documents. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### Training;

An outline for the HVAC control system training course with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training. Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course.

#### SD-06 Test Reports

##### Commissioning Report; G, AE.

Six copies of the HVAC Control System Commissioning Report, in booklet form and indexed, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning procedures and shall follow the format of the commissioning procedures. The commissioning report shall include all configuration checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, results of adjustments, and results of testing.

##### Performance Verification Test; G, AE.

Six copies of the HVAC Control System Performance Verification Test Report, in booklet form and indexed, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of all data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

#### SD-10 Operation and Maintenance Data

##### Operation Manual;

##### Maintenance and Repair Manual;

Six copies of the HVAC Control System Operation Manual and HVAC Control System Maintenance and Repair Manual, for each HVAC control system, 30 days before the date scheduled for the training course.

#### 1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and

temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

#### 1.5 OPERATION MANUAL

An HVAC control system operation manual in indexed booklet form shall be provided for each HVAC control system. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built configuration checksheets, the procedures for changing HVAC control system setpoints, and the procedures for placing HVAC system controllers in the manual control mode.

a. The procedures for changing HVAC control system setpoints shall describe the step-by-step procedures required to change the process variable setpoints, the alarm setpoints, the bias settings, and setpoint reset schedules.

b. The procedures for placing HVAC system controllers in the manual control mode shall describe step-by-step procedures required to obtain manual control of each controlled device and to manually adjust their positions.

#### 1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual in indexed booklet form in hardback binders shall be provided for each HVAC control system. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet.

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment data compliance booklet and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet shall include the equipment compliance booklet and manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

#### 1.7 MAINTENANCE AND SERVICE

Services, materials and equipment shall be provided as necessary to

maintain the entire system in an operational state as specified for a period of one year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized.

#### 1.7.1 Description of Work

The adjustment and repair of the system shall include the manufacturer's required adjustments of computer equipment, software updates, transmission equipment and instrumentation and control devices.

#### 1.7.2 Personnel

Service personnel shall be qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

#### 1.7.3 Scheduled Inspections

Two inspections shall be performed at six-month intervals (or less if required by the manufacturer), and all work required shall be performed. Inspections shall be scheduled in June and December. These inspections shall include:

- a. Visual checks and operational tests of equipment.
- b. Fan checks and filter changes for control system equipment.
- c. Clean control system equipment including interior and exterior surfaces.
- d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog points during the first inspection. Check and calibrate the remaining 50 percent of the analog points during the second major inspection. Certify analog test instrumentation accuracy to be twice that of the device being calibrated. Randomly check at least 25 percent of all digital points for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital points during the second inspection.
- e. Run system software diagnostics and correct diagnosed problems.
- f. Resolve any previous outstanding problems.

#### 1.7.4 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays.

#### 1.7.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition within three calendar days after receiving a request for service.

#### 1.7.6 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

#### 1.7.7 Records and Logs

Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

#### 1.7.8 Work Requests

Each service call request shall be recorded as received and shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

#### 1.7.9 System Modifications

Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

#### 1.7.10 Software

Updates to the software shall be provided for system, operating and application software, and operation in the system shall be verified. Updates shall be incorporated into operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the latest released version of the Contractor's software shall be installed and validated.

### PART 2 PRODUCTS

#### 2.1 GENERAL EQUIPMENT REQUIREMENTS

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two years' use shall include applications of equipment and materials under similar circumstances and of similar size. The two years' experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial

market through advertisements, manufacturers' catalogs, or brochures. Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6,000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Automatic temperature controls shall be direct digital controls that will provide the required sequence of operation.

#### 2.1.1 Electrical and Electronic Devices

Electrical, electronic, and electropneumatic devices not located within a DDC panel shall have a NEMA ICS 1 enclosure in accordance with NEMA 250 unless otherwise shown.

#### 2.1.2 Standard Signals

Except for air distribution terminal unit control equipment, the output of all analog transmitters and the analog input and output of all DDC controllers shall be 4-to-20 mA<sub>dc</sub> signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

#### 2.1.3 Ambient Temperature Limits

DDC panels shall have ambient condition ratings of 35 to 120 degrees F and 10 to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 35 to plus 150 degrees F. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

#### 2.1.4 Year 2000 Compliance

All equipment and software shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations, when used in accordance with the product documentation provided by the contractor, provided that all products (e.g. hardware, software, firmware) used in combination with other information technology, shall accurately process date/time data if other information technology properly exchanges date/time data with it.

### 2.2 WIRING

#### 2.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

#### 2.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

### 2.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

### 2.2.4 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single- or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

### 2.2.5 Transformers

Step down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508 and NEMA ST 1.

## 2.3 ACTUATORS

Actuators shall be electric or electronic as shown and shall be provided with mounting and connecting hardware. Electric or electronic actuators shall be used for variable air volume (VAV) air terminal units. Actuators shall fail to their spring-return positions on signal or power failure, except that VAV terminal unit actuators may be of the floating type. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less. Electric actuators shall have an oil-immersed gear train. Electric or electronic actuators operating in series shall have an auxiliary actuator driver. Electric or electronic actuators used in sequencing applications shall have an adjustable operating range and start point.

### 2.3.1 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation.

## 2.4 AUTOMATIC CONTROL VALVES

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Unless otherwise stated, valves shall have globe style bodies. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv. Unless otherwise specified, bodies for valves 1-1/2 inches and smaller shall be brass or bronze, with threaded or union ends; bodies for 2 inch valves shall have threaded ends; and bodies for valves 2 to 3 inches shall be of brass, bronze or iron. Bodies for valves 2-1/2 inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 to 125 percent of the Cv shown.

#### 2.4.1 Butterfly Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies and noncorrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from minus 20 to plus 250 degrees F. Valves shall have a manual means of operation independent of the actuator. The rated Cv for butterfly valves shall be the value Cv at 70% open (60 degrees open).

#### 2.4.2 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

#### 2.4.3 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

#### 2.4.4 Duct-Coil and Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be furnished for each flare-type end valve.

#### 2.4.5 Valves for Chilled-Water, with Glycol Service

Internal valve trim shall be bronze except that valve stems may be type 316 stainless steel. Valve Cv shall be within 100 to 125 percent of the Cv shown. Valves 4 inches and larger shall be butterfly.

#### 2.4.6 Valves for Hot-Water

For hot water service below 250 degrees F internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 210 degrees F shall be Type 316 stainless steel. Internal trim for valves controlling water 210 degrees F or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 250 degrees F or 50 degrees F above the system design temperature, whichever is higher. Valves 4 inches and larger shall be butterfly valves.

### 2.5 DAMPERS

#### 2.5.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Damper axles shall be 0.5 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 feet per minute in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall

be tested in accordance with AMCA Std 500.

### 2.5.2 Operating Links

Operating links external to dampers, such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

### 2.5.3 Damper Types

Dampers shall be parallel-blade type.

#### 2.5.3.1 Outside Air, Return Air, and Relief Air Dampers

Outside air, return air and relief air dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gauge static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 200 degrees F. Dampers shall be rated at not less than 2,000 feet per minute air velocity.

#### 2.5.3.2 Mechanical and Electrical Space Ventilation Dampers

Mechanical and electrical space ventilation dampers shall be as shown. Dampers shall not leak in excess of 80 cfm square foot at 4 inches water gauge static pressure when closed. Dampers shall be rated at not less than 1,500 feet per minute air velocity.

### 2.6 SMOKE DETECTORS

Duct smoke detectors shall be provided in supply and return air ducts in accordance with Section 13851 Fire Detection and Alarm System, Addressable.

### 2.7 INSTRUMENTATION

#### 2.7.1 Measurements

Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for an output of 4 to 20 mAdc:

- a. Conditioned space temperature, from 50 to 85 degrees F.
- b. Duct temperature, from 40 to 140 degrees F.
- c. High-temperature hot-water temperature, from 200 to 500 degrees F.
- d. Chilled-water temperature, from 30 to 100 degrees F.
- e. Dual-temperature water, from 30 to 240 degrees F.
- f. Heating hot-water temperature, from 50 to 250 degrees F.

- g. Condenser-water temperature, from 30 to 130 degrees F.
- h. Outside-air temperature, from minus 30 to 130 degrees F.
- i. Relative humidity, 0 to 100 percent for space and duct high-limit applications.
- j. Differential pressure for VAV supply-duct static pressure from 0 to 2.0 inches water gauge.
- k. Pitot-tube air-flow measurement station and transmitter, from 0 to 0.1 inch water gauge for flow velocities of 700 to 1200 fpm, 0 to 0.25 inch water gauge for velocities of 700 to 1800 fpm, or 0 to 0.5 inch water gauge for velocities of 700 to 2500 fpm.
- l. Electronic air-flow measurement station and transmitter, from 125 to 2500 fpm.

## 2.7.2 Temperature Instruments

### 2.7.2.1 Resistance Temperature Detectors (RTD)

Temperature sensors shall be 100 ohms 3- or 4-wire RTD. Each RTD shall be platinum with a tolerance of 0.54 degrees F at 32 degrees F with a temperature coefficient of resistance (TCR) of .00214 ohms/ohm/deg F and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified, integrally mounted unless otherwise shown.

### 2.7.2.2 Continuous Averaging RTD

Continuous averaging RTDs shall have a tolerance of plus or minus 1.0 degree F at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross section in which it is installed. The sensing element shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter to match the resistance range of the averaging RTD.

### 2.7.2.3 RTD Transmitter

The RTD transmitter shall match the resistance range of the RTD. The transmitter shall be a two-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mA<sub>dc</sub> output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated measurement.

## 2.7.3 Relative Humidity Instruments

A relative-humidity instrument for indoor application shall have a measurement range from 0 to 100 percent relative-humidity and be rated for operation at ambient air temperatures within the range of 25 to 130 degrees F. It shall be capable of being exposed to a condensing air stream (100 percent RH) with no adverse effect to the sensor's calibration or other harm to the instrument. The instrument shall be of the wall-mounted or duct-mounted type, as required by the application, and shall be provided with any required accessories. Instruments used in duct high-limit applications shall have a bulk polymer resistive sensing element. Duct-mounted instruments shall be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage.

The instrument (sensing element and transmitter) shall be a two-wire, loop-powered device and shall have an accuracy of plus or minus three percent of full scale within the range of 20 to 80 percent relative humidity. The instrument shall have a typical long-term stability of 1 percent or less drift per year. The transmitter shall convert the sensing element's output to a linear 4-20 mAdc output signal in proportion to the measured relative-humidity value. The transmitter shall include offset and span adjustments.

#### 2.7.4 Electronic Airflow Measurement Stations and Transmitters

##### 2.7.4.1 Stations

Each station shall consist of an array of velocity sensing elements and an air-flow straightener. Air-flow straightener shall be contained in a flanged sheet metal or aluminum casing. The velocity sensing elements shall be of the RTD or thermistor type, producing a temperature compensated output. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published application data of the station manufacturer. The resistance to air flow through the airflow measurement station shall not exceed 0.08 inch water gauge at an airflow of 2,000 fpm. Station construction shall be suitable for operation at airflows of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus three percent over a range of 125 to 2,500 fpm. In outside air measurement or in low-temperature air delivery applications, the station shall be certified by the manufacturer to be accurate as specified over a temperature range of minus 20 to plus 120 degrees F. In outside air measurement applications, the air flow straightener shall be constructed of 1/8 inch aluminum honeycomb and the depth of the straightener shall not be less than 1.5 inches.

##### 2.7.4.2 Transmitters

Each transmitter shall produce a linear, 4-to-20 mAdc, output corresponding to the required velocity pressure measurement. The transmitter shall be a two-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the calibrated measurement.

#### 2.7.5 Pitot Tube Airflow Measurement Stations and Transmitters

##### 2.7.5.1 Stations

Each station shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be of the multiple pitot tube type with averaging manifolds. The sensing elements shall be distributed across the duct cross section in the quantity and pattern specified by the published installation instructions of the station manufacturer. The resistance to air flow through the airflow measurement station shall not exceed 0.08 inch water gauge at an airflow of 2,000 fpm. Station construction shall be suitable for operation at airflows of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus three percent over a range of 500 to 2,500 fpm. This device will not be used if the required velocity measurement is below 700 fpm or for outside airflow measurements.

##### 2.7.5.2 Transmitters

Each transmitter shall produce a linear 4-to-20 mAdc output corresponding

to the required velocity pressure measurement. Each transmitter shall have a low range differential pressure sensing element. The transmitter shall be a two-wire, loop powered device. Sensing element accuracy shall be plus or minus one percent of full scale, and overall transmitter accuracy shall be plus or minus 0.25 percent of the calibrated measurement.

#### 2.7.6 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus two percent of full scale. The transmitter shall be a two-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required pressure measurement.

#### 2.7.7 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 2 inch lagging neck and extension type well. Inside diameter and insertion length shall be as required for the application.

#### 2.7.8 Sunshields

Sunshields for outside air temperature sensing elements shall prevent the sun from directly striking the temperature sensing elements. The sunshields shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sunshield shall have a galvanized metal rainshield projecting over the face of the sunshield. The sunshields shall be painted white.

### 2.8 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

#### 2.8.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 5 degrees F. Room thermostats shall be enclosed with separate locking covers (guards).

#### 2.8.2 Microprocessor Based Room Thermostats

Microprocessor based thermostats shall have built-in keypads for scheduling of day and night temperature settings. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, the display shall be used for interrogating time program ON-OFF setpoints for all seven days of the week.

The time program shall allow two separate temperature setback intervals per day. The thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for one year in the event of a power outage. Maximum differential shall be 2 degrees F. When used for heat pump applications, the thermostat shall have an emergency heat switch.

### 2.8.3 Modulating Room Thermostats

Modulating room thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output. Room thermostats shall be enclosed with separate locking covers (guards).

### 2.8.4 Nonmodulating Capillary Thermostats and Aquastats

Each thermostat shall have a capillary length of at least 5 feet, shall have adjustable direct-reading scales for both setpoint and differential, and shall have a differential adjustable from 6 to 16 degrees F. Aquastats shall be of the strap on type, with 10 degrees F fixed differential.

### 2.8.5 Freezestats

Freezestats shall be manual reset, low temperature safety thermostats, with NO and NC contacts and a 20 foot element which shall respond to the coldest 18 inch segment.

### 2.8.6 Modulating Capillary Thermostats

Each thermostat shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Thermostats shall have adjustable throttling ranges of 4 to 8 degrees F for each output.

## 2.9 PRESSURE SWITCHES

### 2.9.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

### 2.9.2 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. The setpoint shall not be in the upper or lower quarters of the range and the range shall not be more than three times the setpoint. Differential shall be a maximum of 0.15 inch water gauge at the low end of the range and 0.35 inch water gauge at the high end of the range.

## 2.10 INDICATING DEVICES

### 2.10.1 Thermometers

#### 2.10.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.

#### 2.10.1.2 Piping System Thermometer Stems

Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

#### 2.10.1.3 Nonaveraging Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

#### 2.10.1.4 Averaging Air-Duct Thermometers

Averaging thermometers shall have a 3-1/2 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270-degree arc.

#### 2.10.1.5 Accuracy

Thermometers shall have an accuracy of plus or minus one percent of scale range. Thermometers shall have a range suitable for the application.

#### 2.10.2 Pressure Gauges

Gauges shall be 2 inch (nominal) size, back connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270-degree arc. Accuracy shall be plus or minus three percent of scale range. Gauges shall meet requirements of ASME B40.1.

##### 2.10.2.1 Hydronic System Gauges

Gauges for hydronic system applications shall have ranges and graduations as shown.

#### 2.10.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements shall be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus two percent of scale range.

### 2.11 CONTROL DEVICES AND ACCESSORIES

#### 2.11.1 Relays

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of two sets of contacts (two normally open, two normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Time delay relays shall be 2PDT with eight-pin connectors, dust cover, and a matching rail-mounted socket. Adjustable timing range shall be 0 to 5 minutes. Power consumption shall not be greater than three watts.

#### 2.11.2 Current Sensing Relays

Current sensing relays shall provide a normally-open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, noninductive. There shall be a single hole for passage of current carrying conductors. The devices shall be sized for operation at 50 percent rated current based on the connected load. Voltage isolation shall be a minimum of 600 volts.

### 2.11.3 Power-Line Conditioners (PLC)

Power line conditioners shall be furnished for each DDC panel. The PLCs shall provide both voltage regulation and noise rejection. The PLCs shall be of the ferro-resonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power-line side. The PLCs shall be sized for 125 percent of the actual connected kVA load. Characteristics of the PLC shall be as follows:

a. At 85 percent load, the output voltage shall not deviate by more than plus or minus one percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus three percent of nominal voltage. Full correction of load switching disturbances shall be accomplished within five cycles, and 95 percent correction shall be accomplished within two cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

### 2.12 DIRECT DIGITAL CONTROL (DDC) HARDWARE

All functions, constraints, data base parameters, operator developed programs and any other data shall be downloadable from a portable workstation/tester or the central workstation/tester to network control panels, RIU's, universal programmable controllers, and unitary controllers.

Download shall be accomplished through both the primary network and the local DDC portable workstation/tester port.

#### 2.12.1 Network Control Panel

Network control panels shall be microcomputer-based with sufficient memory provided to perform all specified and shown network control panel functions and operations, including spare capacity for all spares and its I/O functions specified. Each network control panel and remote I/O units (RIU) shall have a minimum of 10% of its I/O functions as spare capacity but not less than 2 of each type used in each. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall there be less than two spare points of each type. The panel I/O functions shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points shall necessitate only providing the additional field sensor or control device, field wiring including connection to the system, and point definition assignment by the operator using the central workstation/tester or portable workstation/tester. The panel shall contain all necessary I/O functions to connect to field sensors and control panels. I/O function operation shall be fully supervised to detect I/O function failures. Network control panels shall operate in an

independent stand-alone mode, which is defined as all network control panel operations performed by the network control panel without any continuing input from other Direct digital controls or portable workstation/tester. The network control panel shall be capable of controlling a mix of at least 32 RIUs, unitary controllers, and universal programmable controllers.

#### 2.12.1.1 Integral Features

The network control panel shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and if necessary power supply.
- d. Manufacturers control network port.
- e. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the field panel, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.
- g. An intrusion detection device, connected as an alarm.

#### 2.12.1.2 Communication Interfaces

The following communication capabilities shall function simultaneously.

- a. Manufacturers Control Network. Manufacturers control network communications interfaces for each data transmission systems (DTS) circuit between network control panels and RIUs, unitary controllers, and universal programmable controllers, shall be provided. Communication interfaces shall be provided between each network control panel and associated I/O functions. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the network control panel enclosure.
- b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. Network control panel workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel.
- c. Primary Network Port. The network control panel shall either have a built in primary network Port or be capable of accepting a primary network port expansion card for future networking to a base wide utility monitoring and control system (UMCS). The primary network port expansion card shall be either Ethernet (IEEE802.3) or ARCNET.

#### 2.12.1.3 Memory and Real Time Clock (RTC) Backup

The network control panel memory and real time clock functions shall continue to operate for a minimum of 72 hours in the event of a power failure. If rechargeable batteries are provided, automatic charging of batteries shall be provided. Whenever a either a permanent

workstation/tester or portable workstation/tester is monitoring the network control panel, a low battery alarm message shall be sent to it.

#### 2.12.1.4 Duplex Outlet

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the network control panel enclosure.

#### 2.12.1.5 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each network control panel.

#### 2.12.1.6 Failure Mode

Upon failure of the network control panel, either due to failure of the network control panel hardware or of the manufacturers control network, the network control panel shall revert to the failure mode as shown.

a. Manufacturers Control Network Failure: Upon failure of the manufacturers control network, the network control panel shall operate in an independent stand-alone mode.

b. Network Control Panel Hardware Failure: Upon failure of the network control panel hardware, the network control panel shall cease operation and stop communications with other network control panels, RIUs, unitary controllers and universal programmable controllers connected to the affected network control panel. The affected network control panel shall respond to this failure as specified and shown.

#### 2.12.2 RIU

The RIU shall be functionally a part of the network control panel as specified, but may be remotely located from the network control panel and communicate over a dedicated communication circuit. When remotely located, the I/O functions shall be subject to the same requirements as for the network control panel hardware. RIUs shall be used to connect remote inputs and outputs to a network control panel and shall contain all necessary I/O functions to connect to field sensors and control devices. RIU operation shall be fully supervised by the network control panel to detect failures. Each RIU shall have a minimum of 10 % of its I/O functions as spare capacity. The type of spares shall be in the same proportion as the implemented I/O functions on the RIU, but in no case shall there be less than two spare points of each type. The RIU shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points by others shall require only providing the additional field sensor or control device, field wiring including connection to the system, and point definition assignment by the operator. The RIU shall either report the status of all connected points on each scan, or report the status of all points which have changed state or value since the previous scan.

##### 2.12.2.1 Integral Features

The RIU shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and if necessary power supply.
- d. Manufacturers control network port.
- e. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the RIU, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the RIU for further processing.
- f. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual output override, for each AO. The status of these shall be available to the panel for further processing.
- g. An intrusion detection device, connected as an alarm.

#### 2.12.2.2 Duplex Outlet

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the RIU.

#### 2.12.2.3 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each RIU.

#### 2.12.2.4 Failure Mode

Upon failure of the RIU, either due to failure of the RIU hardware or of the DTS, the RIU shall revert to the failure mode shown.

#### 2.12.3 Universal Programmable Controller (UPC)

The universal programmable controller shall be a microprocessor based controller designed and programmed to control and monitor systems as shown.

Resident programs shall be contained in reprogrammable nonvolatile memory. Each universal programmable controller shall contain necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide control and monitoring of connected equipment and devices. It shall contain all necessary I/O functions to connect to field sensors and controls. I/O operation shall be fully supervised to detect I/O function failures. It shall provide for operation as a device connected to the system via the manufacturers control network.

##### 2.12.3.1 Integral Features

The universal programmable controller shall include as a minimum:

- a. Main power switch.
- b. Power on indicator.

c. Portable workstation/tester port, connector, and if necessary power supply.

d. Manufacturers control network port.

e. I/O functions

(1) 8 DI

(2) 4 DO

(3) 8 AI

(4) 4 AO

f. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the universal programmable controller, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.

#### 2.12.3.2 Communication Interfaces

The UPC shall have the following communication capabilities which shall function simultaneously.

a. Manufacturers Control Network. The manufacturers control network communications interface for a data transmission systems (DTS) circuit between the UPC and a network control panels shall be provided. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the UPC Panel enclosure.

b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. A UPC workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel.

#### 2.12.3.3 Memory and RTC Backup

The UPC memory and real time clock functions shall continue to operate for a minimum of 72 hours in the event of a power failure. If rechargeable batteries are provided, automatic charging of batteries shall be provided. Whenever either a permanent workstation/tester or portable workstation/tester is monitoring the network control panel, a low battery alarm message shall be sent to it.

#### 2.12.3.4 Specific Requirements

Each universal programmable controller shall be accessible for purposes of application selection, control parameters, set point adjustment, and monitoring from any DDC controller connected to the same manufacturers control network as the universal programmable controller. This shall be done using a portable workstation/tester connected to a portable workstation/tester port either directly or via modem.

#### 2.12.3.5 Locking Enclosures

Locking type mounting cabinets with common keying shall be furnished for each enclosure.

#### 2.12.3.6 Failure Mode

Upon failure of the universal programmable controller, it shall revert to the failure mode of operation as shown.

#### 2.12.4 Unitary Controller

The unitary controller shall be a microprocessor based, stand-alone, dedicated purpose controller, communicating with the network control panel, designed and programmed to control air distribution system mixing boxes, terminal units, heat pumps, fan coil units, self-contained DX units or VAV boxes as shown. Each unitary controller shall contain resident programs in nonvolatile memory for each specific application implemented. Each unitary controller shall contain necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide control and monitoring of connected equipment and devices. It shall contain all necessary I/O functions to connect to field sensors and controls. I/O operation shall be fully supervised to detect I/O function failures and shall provide for operation as a device connected to the network control panel via the manufacturers control network.

##### 2.12.4.1 Integral Features

The unitary controller shall include:

- a. Main power switch.
- b. Power on indicator.
- c. Portable workstation/tester port, connector, and power supply.
- d. Manufacturers control network port.
- e. All I/O functions required to implement the requirements as shown.
- f. On-Off-Auto switches for each DO which controls a device. These switches shall be mounted in the field panel, with the exception of motors, for which the switch shall be mounted at the motor control center. On-Off-Auto switches are not required for DO associated with a status or alarm such as pilot lights. The status of these switches shall be available to the panel for further processing.

##### 2.12.4.2 Communication Interfaces

The unitary controller shall have the following communication capabilities which shall function simultaneously.

- a. Manufacturers Control Network. The manufacturers control network communications interface for a data transmission systems (DTS) circuit between the unitary controller and a network control panel shall be provided. The DTS will provide for transmission speeds necessary to comply with performance requirements specified. DTS equipment shall be installed in the unitary control panel enclosure.

b. Portable Workstation/Tester Port. A communications port for interfacing to a portable workstation/tester shall be provided. A unitary controller workstation/tester port other than RS-232, shall be converted to RS-232, including cabling and power supply, and shall be permanently installed in the panel. For unitary controller applications where the controller is not mounted in an enclosure, such as for fan-coil units or VAV terminal units, a portable conversion device for an RS-232 connection to the portable workstation/tester may be provided.

#### 2.12.4.3 Specific Requirements

Unitary controller components for new air distribution terminal units shall be furnished to the air distribution terminal unit manufacturer for factory mounting and calibration. Existing air distribution terminal units shall be controlled by field installed unitary controllers.

a. Accessibility and Interfaces: Each unitary controller shall be accessible for purposes of application selection, control parameters, set point adjustment, and monitoring using a portable workstation/tester connected to the manufacturers control network. They shall also be accessible with a portable workstation/tester connected to the unitary controller portable workstation/tester port.

b. Air Distribution Terminal Unit Controls - Pressure Independent: Controls shall consist of a transducer for connection to the velocity-sensing device provided by the terminal unit supplier in the primary air entering the terminal unit, a room temperature sensor, a damper actuator, and an adjustable microprocessor-based controller. The controller shall operate the damper for cooling and heating and provide control outputs for duct heating coil if applicable. This controller capability shall allow the sequencing of the damper and the heating coil to maintain conditions in the space.

c. Air Distribution Terminal Unit Controls - Pressure Independent with Recirculating Fan: Controls for pressure-independent boxes with recirculating fans shall consist of a transducer for connection to the velocity-sensing device provided by the terminal unit supplier in the primary air entering the terminal unit, a room temperature sensing element, a damper actuator, an adjustable microprocessor-based terminal unit controller, and a switch to operate the recirculation fan, provided by the terminal unit supplier. The controller shall operate the damper for cooling and shall provide outputs for controlling the recirculation fan and duct heating coil in sequence for heating.

d. Air Distribution Terminal Unit Damper Actuator: Air distribution terminal unit damper actuator shall open or close the device to which it is connected within 60 seconds.

#### 2.12.4.4 Failure Mode

Upon failure of the unitary controller, it shall revert to the failure mode of operation as shown.

#### 2.12.5 I/O Functions

##### 2.12.5.1 DDC Hardware I/O Functions

I/O Functions shall be provided as part of the DDC system and shall be in accordance with the following:

a. The analog input (AI) function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. The A-to-D conversion shall have a minimum resolution of 10 bits plus sign. Signal conditioning shall be provided for each analog input. Analog inputs shall be individually calibrated for zero and span, in hardware or in software. The AI shall incorporate common mode noise rejection of 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of 20 dB at 60 Hz from a source impedance of 10,000 ohms. Input ranges shall be within the range of 4-to-20 mAdc.

b. The analog output (AO) function shall accept digital data, perform D-to-A conversion, and output a signal within the range of 4-to-20 mAdc. D-to-A conversion shall have a minimum resolution of eight bits plus sign. Analog outputs shall be individually calibrated for zero and span. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided.

c. The digital input (DI) function shall accept on-off, open-close, or other change of state (two state data) indications. Isolation and protection against an applied steady-state voltage up to 180 Vac peak shall be provided.

d. The digital output (DO) function shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second. DO relays shall have an initial breakdown voltage between contacts and coil of at least 500 V peak. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to nondamaging levels. Protection against an applied steady-state voltage up to 180 Vac peak shall be provided. Minimum contact rating shall be one ampere at 24 Vac.

e. The pulse accumulator function shall have the same characteristics as the DI. In addition, a buffer shall be provided to totalize pulses and allow for interrogation by the DDC system. The pulse accumulator shall accept rates up to 20 pulses per second. The totalized value shall be reset to zero upon operator's command.

f. Signal conditioning for sensors shall be provided as specified.

g. The binary coded decimal (BCD) function: The BCD function shall have the same characteristics as the DI, except that, in addition, a buffer shall be provided to totalize inputs and allow for interrogation by the network control panel. The BCD function shall have 16-channel optically isolated buffered inputs to read four digit numbers. The BCD function shall accumulate inputs at rates up to 10 inputs per second.

#### 2.12.5.2 Failure Mode

Upon failure of the I/O function, including data transmission failure, logic power supply failure, DDC processor malfunction, software failure, interposing relay power failure, or any other failure which prevents stand alone operation of any DDC normally capable of stand alone operation, connected outputs shall be forced to the failure mode shown.

#### 2.13 DDC SOFTWARE

All DDC software described in this specification shall be furnished as part of the complete DDC System.

### 2.13.1 Operating System

Each DDC shall contain an operating system that controls and schedules that DDC's activities in real time. The DDC shall maintain a point database in its memory that includes all parameters, constraints, and the latest value or status of all points connected to that DDC. The execution of DDC application programs shall utilize the data in memory resident files. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. Each DDC real time clock shall be automatically synchronized with the network control panel real time clock at least once per day to plus or minus 10 seconds. When the network control panel is connected to a central workstation/tester, the network control panel RTC shall be updated by the central workstation/tester RTC. The time synchronization shall be accomplished without operator intervention and without requiring system shutdown. The operating system shall allow loading of software, data files data entry, and diagnostics from the central workstation/tester both locally through the central workstation/tester port and remotely through a network control panel and the manufacturers control network.

#### 2.13.1.1 Startup

The DDC shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A DDC restart program based on detection of power failure at the DDC shall be included in the DDC software. Upon restoration of power to the DDC, the program shall restart equipment and restore loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the DDC, if the database and application software are no longer resident or if the clock cannot be read, the DDC shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made. If the database and application programs are resident, the DDC shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each DDC shall include a unique time delay setting for each control output when system operation is initiated.

#### 2.13.1.2 Operating Mode

Each DDC shall control and monitor functions as specified, independent of communications with other DDC. This software shall perform all DDC functions and DDC resident application programs as specified using data obtained from I/O functions and based upon the DDC real time clock function. When communications circuits between the DDC are operable, the DDC shall obtain real time clock updates and any required global data values transmitted from other network control panels. The DDC software shall execute commands after performing constraints checks in the DDC. Status and analog values, including alarms and other data shall be transmitted from other network control panels when communications circuits are operable. If communications are not available, each DDC shall function in stand-alone mode and operational data, including the latest status and value of each point and results of calculations, normally transmitted from other network control panels shall be stored for later transmission to the network control panel. Storage for the latest 256 values shall be provided at each network control panel. Each DDC shall accept software downloaded

from the network control panel. Constraints shall reside at the DDC.

#### 2.13.1.3 Failure Mode

Upon failure for any reason, each DDC shall perform an orderly shutdown and force all DDC outputs to a predetermined (failure mode) state, consistent with the failure modes shown and the associated control device.

#### 2.13.2 Functions

The Contractor shall provide software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within each network control panel, RIU, unitary controller and universal programmable controller.

- a. Scanning of inputs.
- b. Control of outputs.
- c. Reporting of analog changes outside a selectable differential.
- d. Reporting of unauthorized digital status.
- e. Reporting of alarms automatically to network control panel.
- f. Reporting of I/O status to network control panel upon request.
- g. Maintenance of real time, updated by the network control panel at least once a day.
- h. Communication with the network control panel.
- i. Execution of DDC resident application programs.
- j. Averaging or filtering of AIs.
- k. Constraints checks (prior to command issuance).
- l. Diagnostics.
- m. Portable workstation/tester operation as specified.
- n. Reset of PA by operator based on time and value.

##### 2.13.2.1 Analog Monitoring

The system shall measure and transmit analog values including calculated analog points. An analog change in value is defined as a change exceeding a preset differential value as specified. The record transmitted for each analog value shall include a readily identifiable flag which indicates the abnormal status of the value when it deviates from operator selectable upper and lower analog limits. Analog values shall be expressed in proper engineering units with sign. Engineering units conversions shall be provided for each measurement. Each engineering units conversion set shall include range, span, and conversion equation. A vocabulary of engineering unit descriptors shall be provided, using at least three alphanumeric characters to identify information in the system. The system shall support 255 different engineering units.

#### 2.13.2.2 Logic (Virtual) Points

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. Logic (virtual) points shall be analog or digital points created by calculation from any combination of digital and analog points, or other data having the properties of real points, including alarms, without the associated hardware. Logic (virtual) points shall be defined or calculated and entered into the database by the Contractor. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Constants used in calculations shall be changeable on-line by the operator. Calculated point values shall be current for use by the system within 10 seconds of the time of any input changes.

#### 2.13.2.3 State Variables

If an analog point represents more than two (up to eight) specific states, each state shall be nameable. For example, a level sensor shall be displayed at its measured engineering units plus a state variable with named states usable in programs or for display such as low alarm/low/normal/high/high alarm.

#### 2.13.2.4 Analog Totalization

Any analog point shall be operator assignable to the totalization program. Up to eight analog values shall be totalized within a selectable time period. At the end of the period, the totals shall be stored. Totalization shall then restart from zero for the next time period. The program shall keep track of the peak and total value measured during the current period and for the previous period. The operator shall be able to set or reset each totalized value individually. The time period shall be able to be operator defined, modified or deleted on-line.

#### 2.13.2.5 Energy Totalization

The system shall calculate the heat energy in Btus, for each energy source consumed by the mechanical systems specified, totalize the calculated Btus, the instantaneous rate in Btus per hour, and store totals in thousands of Btus (MBtu). The Btus calculated shall be totalized for an adjustable time period. The time period shall be defined uniquely for each Btu totalization.

#### 2.13.2.6 Trending

Any analog or calculated point shall be operator assignable to the trend program. Up to eight points shall be sampled at individually assigned intervals, selectable between one minute and two hours. A minimum of the most recent 128 samples of each trended point shall be stored. The sample intervals shall be able to be defined, modified, or deleted on-line.

#### 2.13.3 I/O Point Database/Parameter Definition

Each I/O point shall be defined in a database residing in the DDC. The definition shall include all physical parameters associated with each point. Each point shall be defined and entered into the database by the Contractor, including as applicable:

- a. Name.
- b. Device or sensor type (i.e., sensor, control relay, motors).
- c. Point identification number.
- d. Unit.
- e. Building number.
- f. Area.
- g. Island.
- h. DDC number and channel address.
- i. KW (running).
- j. KW (starting).
- k. Sensor range.
- l. Controller range.
- m. Sensor span.
- n. Controller span.
- o. Engineering units conversion (scale factor).
- p. Setpoint (analog).
- q. High reasonableness value (analog).
- r. Low reasonableness value (analog).
- s. High alarm limit differential (return to normal).
- t. Low alarm limit differential (return to normal).
- u. High alarm limit (analog).
- v. Low alarm limit (analog).
- w. Alarm disable time period upon startup or change of setpoint.
- x. Analog change differential (for reporting).
- y. Alarm class and associated primary message text.
- z. High accumulator limit (pulse).
- aa. Status description.
- bb. Run time target.
- cc. Failure mode as specified and shown.
- dd. Constraints as specified.

#### 2.13.4 Alarm Processing

Each DDC shall have alarm processing software for AI, DI, and PA alarms for all real and virtual points connected to that DDC.

##### 2.13.4.1 Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by DIs as specified and shown.

##### 2.13.4.2 Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an AI. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. Analog alarm limits shall be stored in the DDC database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return into the proper operating range before being annunciated as a return-to-normal-state. All limits and differentials shall be entered on-line by the operator in limits of the measured variable, without interruption or loss of monitoring of the point concerned. The program shall automatically change the high or low limits or both, of any analog point, based on time scheduled operations as specified, allowing for a time interval before the alarm limit becomes effective. In CPA applications, key the limit to a finite deviation traveling with the setpoint. The system shall automatically suppress analog alarm reporting associated with a digital point when that digital point is turned off.

##### 2.13.4.3 Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system. Limits shall be stored in the DDC database.

#### 2.13.5 Constraints

##### 2.13.5.1 Equipment Constraints Definitions

Each control point in the database shall have DDC resident constraints defined and entered by the Contractor, including as applicable:

- a. Maximum starts (cycles) per hour.
- b. Minimum off time.
- c. Minimum on time.
- d. High limit (value in engineering units).
- e. Low limit (value in engineering units).

##### 2.13.5.2 Constraints Checks

Control devices connected to the system shall have the DDC memory resident constraints checked before each command is issued to insure that no equipment damage will result from improper operation. Each command shall be executed by the DDC only after all constraints checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Values outside the reasonableness limits shall be rejected and an alarm message sent to the network control panel or portable workstation/tester. Status changes and analog point values shall be reported to the workstation upon operator request, such as for reports, alphanumeric displays, graphic displays, and application programs. Each individual point shall be capable of being selectively disabled by the operator from a workstation/tester. Disabling a point shall prohibit monitoring and automatic control of that point.

#### 2.13.6 Diagnostics

Each DDC shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be usable in conjunction with the central workstation/tester and portable workstation/tester. The software shall display messages in English to inform the tester's operator of diagnosed problems.

#### 2.13.7 Summer-Winter Operation Monitoring

The system shall provide software to automatically change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system from summer to winter and vice-versa. The software shall provide automatic commands to applications programs to coordinate proper summer or winter operation. Change over setpoints shall be operator selectable and settable.

#### 2.13.8 Control Sequences and Control Loops

Sufficient memory shall be provided to implement the requirements specified and shown for each DDC. Specific functions to be implemented are defined in individual system control sequences and database tables shown in the drawings, and shall include, as applicable, the following:

- a. PI Control: This function shall provide proportional control and proportional plus integral control.
- b. Two Position Control: This function shall provide control for a two state device by comparing a set point against a process variable and an established deadband.
- c. Floating Point Control: This function shall exercise control when an error signal exceeds a selected deadband, and shall maintain control until the error is within the deadband limits.
- d. Signal Selection: This function shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control. The function shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs.
- e. Signal Averaging: This function shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control. The function shall include the ability to "weight" the individual analog values so that the function output can be biased as

necessary to achieve proper control.

f. Reset Function: This function shall develop an AO based on up to two AIs and one operator specified reset schedule.

g. Cooling/Heating Operation Program: Software shall be provided to change, either automatically or on operator command, the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system where such a change from cooling to heating and vice versa is meaningful. The software shall provide commands to application programs to coordinate cooling or heating mode operation. Software shall automatically switch facilities from cooling to heating, and vice versa, based on schedules or temperatures. All HVAC equipment and systems shall be assigned to the program.

#### 2.13.9 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the on and off states, insuring that the correct command shall be issued when the time constraint is no longer in effect or report the rejected command. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

#### 2.13.10 Resident Application Software

The Contractor shall provide resident applications programs to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the DDC system. Application programs shall be resident and shall execute in the DDC, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved. The Contractor shall coordinate the application programs specified with the equipment and controls operation, and other specified requirements. A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the ON and OFF states, insuring that the correct command shall be issued when the time constraint is no longer in effect or the rejected command shall be reported. Override commands entered by the operator shall have higher priority than those emanating from application programs.

##### 2.13.10.1 Program Inputs and Outputs

The Contractor shall select the appropriate program inputs listed for each application program to calculate the required program outputs. Where the specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate. AIs to application programs shall have an operator adjustable deadband to preclude short cycling or hunting. Program outputs shall be real analog or digital outputs or logic (virtual) points as required to provide the specified functions. The Contractor shall select the appropriate input and output signals to satisfy the requirements for control of systems as shown.

#### 2.13.10.2 DDC General Conditions

The Contractor shall provide software required to achieve the sequences of operation, parameters, constraints, and interlocks shown. Application software shall be resident in the DDC in addition to any other required software. In the event of a DDC failure, the controlled equipment shall continue to function in the failure mode shown.

#### 2.13.10.3 Scheduled Start/Stop Program

This program shall start and stop equipment based on a time of day schedule for each day of the week, and on a holiday schedule. To eliminate power surges, an operator adjustable time delay shall be provided between consecutive start commands.

a. Program Inputs:

- (1) Day of week/holiday.
- (2) Time of day.
- (3) Cooling and heating high-low alarm limits.
- (4) Cooling and heating start-stop schedules.
- (5) Cooling or heating mode of operation.
- (6) Equipment status.
- (7) Equipment constraints.
- (8) Consecutive start time delay.

b. Program Outputs: Start/stop signal.

#### 2.13.10.4 Optimum Start/Stop Program

This program shall start and stop equipment as specified for the scheduled start/stop program, but shall include a sliding schedule based on indoor and outdoor air conditions. The program shall take into account the thermal characteristics of the structure, and indoor and outdoor air conditions, using prediction software to determine the minimum time of HVAC system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end without exceeding space environmental requirements. An adaptive control algorithm shall be utilized to automatically adjust the constants used in the program.

a. Program Inputs:

- (1) Day of week/holiday.
- (2) Time of day.
- (3) Cooling or heating mode of operation.
- (4) Equipment status.
- (5) Cooling and heating building occupancy schedules.

- (6) Space temperature.
- (7) Building heating constant (operator adjustable and automatically optimized).
- (8) Building cooling constant (operator adjustable and automatically optimized).
- (9) OA temperature.
- (10) Required space temperature at occupancy (heating).
- (11) Required space temperature at occupancy (cooling).
- (12) Equipment constraints.
- (13) Cooling and heating high-low alarm limits.

b. Program Outputs: Start/stop signal.

#### 2.13.10.5 Day-Night Setback Program

The software shall limit the rise or drop of space temperature (or specified fluid temperature) during unoccupied hours. Whenever the space temperature (or specified fluid temperature) is above (or below for heating) the operator assigned temperature limit, the system shall be turned on until the temperature is within the assigned temperature limit.

a. Program Inputs:

- (1) Day of week.
- (2) Time of day.
- (3) Cooling or heating mode of operation.
- (4) Cooling and heating occupancy schedules.
- (5) Equipment status.
- (6) Space temperature (or specified fluid temperature).
- (7) Minimum space temperature (or specified fluid temperature) during unoccupied periods.
- (8) Maximum space temperature (or specified fluid temperature) during unoccupied periods.
- (9) Equipment constraints.

b. Program Outputs: Start/stop signal.

#### 2.13.10.6 Chiller Selection Program

Chiller program shall be used for chiller selection as well as control and monitoring of chillers. The software shall select the most efficient chiller or combination of chillers based on chiller operating data to satisfy the cooling load. Based on chiller operating data, energy input vs

chilled water output, the chiller with the highest efficiency shall be selected to satisfy the cooling load calculated by prediction software. The program shall calculate equipment electrical energy input based on percent full load, current, or other inputs provided, and equipment nameplate data. The program shall prevent the chiller from going to full load for a predetermined period to allow the system to stabilize, in order to determine the actual cooling load. The program shall follow the chiller manufacturer's startup and shutdown sequence requirements. Interlocks between chilled water pumps, condenser water pumps, and chiller shall be in accordance with the chiller manufacturer's requirements.

a. Program Inputs

- (1) Efficiency curves.
- (2) Chiller water supply temperatures.
- (3) Chiller water return temperatures.
- (4) Chiller water flows.
- (5) Entering condenser water temperatures.
- (6) Leaving condenser water temperatures.
- (7) Condenser water flows.
- (8) Instantaneous KW to chillers.
- (9) Instantaneous KW to chilled water pumps (if variable).
- (10) Instantaneous KW to condenser water pumps (if variable).
- (11) Instantaneous KW to cooling tower fans (if variable).
- (12) Common chilled water supply temperatures.
- (13) Common chilled water return temperatures.
- (14) Total chilled water flow.
- (15) Chilled water pumps status.
- (16) Refrigerant pressure, suction and discharge.
- (17) Equipment constraints.
- (18) Steam flow.

b. Program Outputs

- (1) Start/stop signals for chillers (manual or automatic to control panel).
- (2) Start/stop signals for chilled water pumps (manual or automatic to control panel).
- (3) Start/stop signals for condenser water pumps (manual or automatic to control panel).
- (4) Start/stop signals for cooling tower fans (manual or automatic to control panel).
- (5) Chilled water supply temperature setpoint control signal.
- (6) Chiller efficiency.

2.13.10.7 Boiler Monitoring and Control

The software shall remotely monitor and control boiler operation based on boiler operational data. The program shall monitor inputs and discontinue boiler operation if any monitored point exceeds a predetermined value or changes status incorrectly. The operator shall be able to add or delete individual program input points from the list of points that will discontinue boiler operation.

a. Program Inputs

- (1) Fuel flow.
- (2) Fuel pressure (natural gas).
- (3) Fuel temperature (heated fuel oil).

- (4) Flame status.
- (5) Flue gas oxygen.
- (6) Flue gas temperature.
- (7) Make-up or feed water flow.
- (8) Furnace draft.
- (9) Flue gas carbon monoxide (for boilers over 20 million BTUs).
- (10) Hot water flow.
- (11) Hot water pressure.
- (12) Hot water supply temperature.
- (13) Hot water return temperature.
- (14) Hot water BTUs.
- (15) Steam flow.
- (16) Steam pressure.
- (17) Steam temperature.
- (18) Steam BTUs.
- (19) Feedwater temperature.
- (20) Boiler drum level.

b. Program Outputs

- (1) Boiler enable/disable control signal.
- (2) Boiler enable/disable permission to boiler operator for manual control.
- (3) Boiler efficiency.

### PART 3 EXECUTION

#### 3.1 GENERAL INSTALLATION CRITERIA

##### 3.1.1 HVAC Control System

The HVAC control system shall be completely installed and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

##### 3.1.2 Software Installation

Software shall be loaded for an operational system, including databases for all points, operational parameters, and system, command, and application software. The Contractor shall provide original and backup copies of source, excluding the general purpose operating systems and utility programs furnished by computer manufacturers and the non-job-specific proprietary code furnished by the system manufacturer, and object modules for software on each type of media utilized, within 30 days of formal Government acceptance. In addition, a copy of individual floppy disks of software for each DDC panel shall be provided.

##### 3.1.3 Device Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown.

Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

#### 3.1.4 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. Nonmetallic-sheathed cables or metallic-armored cables may be installed in areas permitted by NFPA 70. Wiring shall be installed without splices between control devices and DDC panels. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

### 3.2 CONTROL SYSTEM INSTALLATION

#### 3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

#### 3.2.2 Room Instrument Mounting

Room instruments , such as wall mounted thermostats, shall be mounted 60 inches above the floor unless otherwise shown. Temperature setpoint devices shall be recess mounted.

#### 3.2.3 Freezestats

For each 20 square feet of coil face area, or fraction thereof, a freezestat shall be provided to sense the temperature at the location shown. Manual reset freezestats shall be installed in approved, accessible locations where they can be reset easily. The freezestat sensing element shall be installed in a serpentine pattern.

#### 3.2.4 Averaging Temperature Sensing Elements

Sensing elements shall have a total element minimum length equal to 1 linear foot per square foot of duct cross-sectional area.

### 3.3 CONTROL SEQUENCES OF OPERATION

#### 3.3.1 General Requirements - HVAC Systems

The sequence of operations shall be as described on the contract drawings.

### 3.4 COMMISSIONING PROCEDURES

#### 3.4.1 Procedures

Commissioning shall be as specified in Section 15995A, "Commissioning of HVAC System".

### 3.5 BALANCING, COMMISSIONING, AND TESTING

#### 3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The contractor shall tune the HVAC control system after all air system and hydronic system balancing has been completed, minimum damper positions set and a report has been issued.

#### 3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Communications requirements shall be as indicated. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

#### 3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the Commissioning Report and completion of balancing. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems.

#### 3.5.4 Endurance Test

The endurance test shall be used to demonstrate the specified overall system reliability requirement of the completed system. The endurance test shall not be started until the Government notifies the Contractor in writing that the performance verification test is satisfactorily completed. The Government may terminate the testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as

specified to the Government prior to acceptance of the system.

a. Phase I (Testing). The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

b. Phase II (Assessment). After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the jobsite to present the results and recommendations to the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and test review meeting, the Government may require that the Phase I test be totally or partially rerun. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

### 3.5.5 Posted and Panel Instructions

Posted and Panel Instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of laminated half-size drawings and shall include the control system schematic, equipment schedule, sequence of operation, wiring diagram, communication network diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a Routine Maintenance Checklist and as-built configuration check sheets. Panel instructions and one copy of the Operation and Maintenance Manuals, previously described herein, shall be placed inside each control panel or permanently affixed, by mechanical means, to a wall near the panel.

## 3.6 TRAINING

### 3.6.1 Training Course Requirements

A training course shall be conducted for operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. The training period, for a total of 32 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and 3 sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

### 3.6.2 Training Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and

are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

## SECTION 15990

TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS  
08/97

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems

## NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB Procedural Stds (1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G, AE.

Three copies of the TAB Schematic Drawings and Report Forms, no later than 21 days prior to the start of TAB field measurements.

## SD-03 Product Data

TAB Related HVAC Submittals;

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB Specialist.

TAB Procedures; G, AE.

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration;

List of each instrument to be used during TAB, stating calibration requirements required or recommended by both the TAB Standard and the instrument manufacturer and the actual calibration history of the instrument, submitted with the TAB Procedures. The

calibration history shall include dates calibrated, the qualifications of the calibration laboratory, and the calibration procedures used.

Systems Readiness Check; G, AE.

Proposed date and time to begin the Systems Readiness Check, no later than 7 days prior to the start of the Systems Readiness Check.

TAB Execution; G, AE.

Proposed date and time to begin field measurements, making adjustments, etc., for the TAB Report, submitted with the Systems Readiness Check Report.

TAB Verification; G, AE.

Proposed date and time to begin the TAB Verification, submitted with the TAB Report.

#### SD-06 Test Reports

Design Review Report; G, AE.

A copy of the Design Review Report, no later than 14 days after approval of the TAB Firm and the TAB Specialist.

Systems Readiness Check; G, AE.

A copy of completed checklists for each system, each signed by the TAB Specialist, at least 7 days prior to the start of TAB Execution. All items in the Systems Readiness Check Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Report; G, AE.

Three copies of the completed TAB Reports, no later than 7 days after the execution of TAB. All items in the TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Verification Report; G, AE.

Three copies of the completed TAB Verification Report, no later than 7 days after the execution of TAB Verification. All items in the TAB Verification Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

#### SD-07 Certificates

Ductwork Leak Testing, G, AE.

A written statement signed by the TAB Specialist certifying that the TAB Specialist witnessed the Ductwork Leak Testing, it was successfully completed, and that there are no known deficiencies

related to the ductwork installation that will prevent TAB from producing satisfactory results.

TAB Firm; G, AE.

Certification of the proposed TAB Firm's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Firm or disciplinary action taken by AABC or NEBB against the proposed TAB Firm shall be described in detail.

TAB Specialist; G, AE.

Certification of the proposed TAB Specialist's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Specialist or disciplinary action taken by AABC or NEBB against the proposed TAB Specialist shall be described in detail.

1.3 SIMILAR TERMS

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC or NEBB requirements where differences exist.

SIMILAR TERMS

Contract Term	AABC Term	NEBB Term
TAB Standard Systems.	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.	Procedural Standards for Testing Adjusting Balancing of Environmental
TAB Specialist	TAB Engineer	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures.

1.4 TAB STANDARD

TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1or NEBB Procedural Stds, unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc., shall, as nearly as practical, be used to

satisfy the Contract requirements. The TAB Standard shall be used for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures shall be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC or NEBB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

## 1.5 QUALIFICATIONS

### 1.5.1 TAB Firm

The TAB Firm shall be either a member of AABC or certified by the NEBB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systemsbuilding systems commissioning. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm shall be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm shall be a subcontractor of the prime Contractor, and shall report to and be paid by the prime Contractor.

### 1.5.2 TAB Specialist

The TAB Specialist shall be either a member of AABC or an experienced technician of the Firm certified by the NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

## 1.6 TAB SPECIALIST RESPONSIBILITIES

All TAB work specified herein and in related sections shall be performed under the direct guidance of the TAB Specialist. The TAB Specialist shall participate in the commissioning process specified in Section 15995 COMMISSIONING OF HVAC SYSTEMS.

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

## 3.1 DESIGN REVIEW

The TAB Specialist shall review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

## 3.2 TAB RELATED HVAC SUBMITTALS

The TAB Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the TAB Specialist when submitted to the Government. The TAB Specialist shall also ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

## 3.3 TAB SCHEMATIC DRAWINGS AND REPORT FORMS

A schematic drawing showing each system component, including balancing devices, shall be provided for each system. Each drawing shall be accompanied by a copy of all report forms required by the TAB Standard used for that system. Where applicable, the acceptable range of operation or appropriate setting for each component shall be included on the forms or as an attachment to the forms. The schematic drawings shall identify all testing points and cross reference these points to the report forms and procedures.

## 3.4 DUCTWORK LEAK TESTING

The TAB Specialist shall witness the Ductwork Leak Testing specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and approve the results as specified in Paragraph TAB RELATED HVAC SUBMITTALS.

## 3.5 TESTING, ADJUSTING, AND BALANCING

## 3.5.1 TAB Procedures

Step by step procedures for each measurement required during TAB Execution shall be provided. The procedures shall be oriented such that there is a separate section for each system. The procedures shall include measures to ensure that each system performs as specified in all operating modes, interactions with other components (such as exhaust fans, kitchen hoods, fume hoods, relief vents, etc.) and systems, and with all seasonal operating differences, diversity, simulated loads, and pressure relationships required.

## 3.5.2 Systems Readiness Check

The TAB Specialist shall inspect each system to ensure that it is complete, including installation and operation of controls, and that all aspects of

the facility that have any bearing on the HVAC systems, including installation of ceilings, walls, windows, doors, and partitions, are complete to the extent that TAB results will not be affected by any detail or touch-up work remaining. The TAB Specialist shall also verify that all items such as ductwork and piping ports, terminals, connections, etc., necessary to perform TAB shall be complete during the Systems Readiness Check.

### 3.5.3 Preparation of TAB Report

Preparation of the TAB Report shall begin only when the Systems Readiness Report has been approved. The Report shall be oriented so that there is a separate section for each system. The Report shall include a copy of the appropriate approved Schematic Drawings and TAB Related Submittals, such as pump curves, fan curves, etc., along with the completed report forms for each system. The operating points measured during successful TAB Execution and the theoretical operating points listed in the approved submittals shall be marked on the performance curves and tables. Where possible, adjustments shall be made using an "industry standard" technique which would result in the greatest energy savings, such as adjusting the speed of a fan instead of throttling the flow. Any deficiencies outside of the realm of normal adjustments and balancing during TAB Execution shall be noted along with a description of corrective action performed to bring the measurement into the specified range. If, for any reason, the TAB Specialist determines during TAB Execution that any Contract requirement cannot be met, the TAB Specialist shall immediately provide a written description of the deficiency and the corresponding proposed corrective action necessary for proper system operation to the Contracting Officer.

### 3.5.4 TAB Verification

The TAB Specialist shall recheck ten percent of the measurements listed in the Tab Report and prepare a TAB Verification Report. The measurements selected for verification and the individuals that witness the verification will be selected by the Contracting Officer's Representative (COR). The measurements will be recorded in the same manner as required for the TAB Report. All measurements that fall outside the acceptable operating range specified shall be accompanied by an explanation as to why the measurement does not correlate with that listed in the TAB Report and a description of corrective action performed to bring the measurement into the specified range. The TAB Specialist shall update the original TAB report to reflect any changes or differences noted in the TAB verification report and submit the updated TAB report. If over 20 percent of the measurements selected by the COR for verification fall outside of the acceptable operating range specified, the COR will select an additional ten percent for verification. If over 20 percent of the total tested (including both test groups) fall outside of the acceptable range, the TAB Report shall be considered invalid and all contract TAB work shall be repeated beginning with the Systems Readiness Check.

### 3.5.5 Marking of Setting

Following approval of TAB Verification Report, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

### 3.5.6 Identification of Test Ports

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

-- End of Section --

## SECTION 15995

COMMISSIONING OF HVAC SYSTEMS  
04/01

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

## Commissioning Team;

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

## Test Procedures; G, AE.

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

## Test Schedule; G, AE.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

## SD-06 Test Reports

## Test Reports; G, AE.

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

## 1.2 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 15951 DIRECT DIGITAL CONTROL FOR HVAC and Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT .

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

## 3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

## 3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

## 3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks

shall be corrected and retested in accordance with the applicable contract requirements.

3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping

For All Piping System

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___

Pre-commissioning checklist - Piping

For All Piping System

Checklist Item	Q	M	E	T	C	D	O	U
b. TAB operation complete.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Ductwork

For Air Handler: All

Checklist Item	Q	M	E	T	C	D	O	U
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Installation

a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___

NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.

d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___]
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
g. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
h. Verify smoke dampers operation.	___	___	X	___	___	___	___	___
i. Flexible connectors installed as specified	___	___	X	___	X	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB operation complete.	___	___	X	___	X	___	___	___
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Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
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Installation

a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed. (Visually verify drainage by pouring a cup of water into drain pan.)	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___

Electrical

a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___

Coils

a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___
b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___
c. Hot water piping properly connected.	___	___	X	X	X	___	___	___
d. Hot water piping pressure tested.	___	___	X	X	X	___	___	___
e. Air vents installed on water coils with shutoff valves as specified.	___	___	X	X	X	___	___	___
f. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___

Controls

a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
e. Verify proper location, installation and calibration of duct static pressure sensor.	___	___	X	___	___	___	___	___
f. Fan air volume controller operable.	___	___	X	___	___	___	___	___
g. Air handler controls system operational.	___	___	X	___	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. Construction filters removed and replaced.	___	___	X	___	___	___	___	___
b. TAB report submitted.	___	___	X	___	X	___	___	___
c. TAB results within +10%/-0% of cfm shown on drawings	___	___	___	___	___	___	___	___
d. TAB results for outside air intake within +10%/-0% of both the minimum and maximum cfms shown on drawings.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. VAV terminal in place.	___	___	X	X	X	___	___	___
b. VAV terminal ducted.	___	___	X	X	X	___	___	___
c. VAV terminal connected to controls.	___	___	X	X	___	___	___	___
d. Reheat coil connected to hot water pipe.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___

Controls

a. Cooling only VAV terminal controls set.	___	___	X	X	___	___	___	___
b. Cooling only VAV controls verified.	___	___	X	X	___	___	___	___
c. Reheat VAV terminal controls set.	___	___	X	X	___	___	___	___
d. Reheat terminal/coil controls verified.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: All

Checklist Item	Q	M	E	T	C	D	O	U
Testing, Adjusting, and Balancing (TAB)								
a. Verify terminal maximum air flow set.	___	___	X	___	___	___	___	___
b. Verify terminal minimum air flow set.	___	___	X	___	___	___	___	___
c. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Pumps

For Pump: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Pumps grouted in place.	___	___	X	X	X	___	___	___
b. Pump vibration isolation devices functional.	___	___	X	X	X	___	___	___
c. Pump/motor coupling alignment verified.	___	___	X	X	X	___	___	___
d. Piping system installed.	___	___	X	X	X	___	___	___
e. Piping system pressure tested.	___	___	X	X	X	___	___	___
f. Pump not leaking.	___	___	X	X	X	___	___	___
g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.	___	___	X	X	X	___	___	___

Electrical

a. Power available to pump disconnect.	___	___	___	X	X	___	___	___
b. Pump rotation verified.	___	___	___	X	X	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. Pressure/temperature gauges installed.	___	___	X	___	X	___	___	___
b. Piping system cleaned.	___	___	X	X	X	___	___	___
c. Chemical water treatment complete.	___	___	X	X	X	___	___	___
d. Water balance complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Pumps

For Pump: All

Checklist Item	Q	M	E	T	C	D	O	U
e. Water balance with design maximum flow.	___	___	X	___	X	___	___	___
f. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Chiller properly piped.	___	___	X	___	___	___	___	___
b. Chilled water pipe leak tested.	___	___	X	X	X	___	___	___
c. Verify that refrigerant used complies with specified requirements.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Separate power is supplied to electric heating tape.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Factory startup and checkout complete.	___	___	X	X	___	___	___	___
b. Chiller safety/protection devices tested.	___	___	X	X	___	___	___	___
c. Chilled water flow switch installed.	___	___	X	X	___	___	___	___
d. Chilled water flow switch tested.	___	___	X	X	___	___	___	___
e. Chilled water pump interlock installed.	___	___	X	X	X	___	___	___
f. Chilled water pump interlock tested.	___	___	___	X	___	___	___	___

Pre-commissioning Checklist - Hot Water Boiler

For Boiler:

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Boiler flue installed.	___	___	X	___	___	___	___	___
b. Boiler hot water piping installed.	___	___	X	___	___	___	___	___
c. Boiler hot water piping tested.	___	___	X	X	___	___	___	___
d. Boiler makeup water piping installed.	___	___	X	___	___	___	___	___
e. Boiler fuel oil piping installed.	___	___	X	X	X	___	___	___
f. Boiler fuel oil piping tested.	___	___	X	X	X	___	___	___
g. Boiler gas piping installed.	___	___	X	X	X	___	___	___
h. Boiler gas piping tested.	___	___	X	X	X	___	___	___
i. Manufacturer's required maintenance clearance provided.	___	___	X	___	___	___	___	___
Startup								
a. Boiler system cleaned and filled with treated water.	___	___	X	___	___	___	___	___
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___	___	___
c. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___	___	___
d. Boiler water treatment system functional.	___	___	X	X	___	___	___	___
e. Boiler startup and checkout complete.	___	___	X	X	___	___	___	___
f. Combustion efficiency demonstrated.	___	___	X	___	X	___	___	___
Electrical								
a. Verify that power disconnect is located within sight of the unit served.	___	___	___	X	___	___	___	___
Controls								
a. Hot water pump interlock installed.	___	___	___	X	___	___	___	___
b. Hot water pump interlock tested.	___	___	___	X	___	___	___	___
c. Hot water heating system balanced.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Hot Water Boiler

For Boiler:

Checklist Item	Q	M	E	T	C	D	O	U
d. Hot water heating controls operational.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Unit Heater

For Unit Heater: All

Checklist Item	Q	M	E	T	C	D	O	U
----------------	---	---	---	---	---	---	---	---

Installation

a. Hot water piping properly connected.	___	___	X	___	___	___	___	___
b. Hot water piping pressure tested.	___	___	X	___	___	___	___	___
c. Air vent installed on hot water coil with shutoff valve as specified.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___

Electrical

a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___	___	___

Controls

a. Control valves properly installed.	___	___	X	___	___	___	___	___
b. Control valves operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB Report submitted.	___	___	X	___	X	___	___	___
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Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to cfm shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - HVAC System Controls

For HVAC System: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Layout of control panel matches drawings.	___	___	X	X	___	___	___	___
c. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
d. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___	___	___
e. Control components piped and/or wired to								

Pre-commissioning Checklist - HVAC System Controls

For HVAC System: All

Checklist Item	Q	M	E	T	C	D	O	U
each labeled terminal strip.	___	___	X	X	___	___	___	___
f. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___	___	___
g. Control wiring and tubing labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
h. Shielded wiring used on electronic sensors.	___	___	X	X	___	___	___	___
i. Air dryer installed as specified.	___	___	X	X	___	___	___	___
j. Water drain installed as specified.	___	___	X	X	___	___	___	___

Main Power and Control Air

a. 110 volt AC power available to panel.	___	___	___	X	___	___	___	___
b. 20 psig compressed air available to panel.	___	___	X	X	___	___	___	___

Testing, Commissioning, and Balancing

a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___
--	-----	-----	---	-----	-----	-----	-----	-----

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed.	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___

Electrical

Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
a. Power available to unit disconnect.	__	__	__	X	X	__	__	__
b. Power available to unit control panel.	__	__	__	X	__	__	__	__
c. Proper motor rotation verified.	__	__	__	__	X	__	__	__
d. Verify that power disconnect is located within sight of the unit it controls.	__	__	__	X	__	__	__	__
e. Power available to electric heating coil.	__	__	__	X	__	__	__	__

Coils

a. Chilled water piping properly connected.	__	__	X	__	__	__	__	__
b. Chilled water piping pressure tested.	__	__	X	X	X	__	__	__
c. Hot water piping properly connected.	__	__	X	__	__	__	__	__
d. Hot water piping pressure tested.	__	__	X	X	__	__	__	__
e. Air vents installed on water coils with shutoff valves as specified.	__	__	X	X	X	__	__	__]
f. Any damage to coil fins has been repaired.	__	__	X	__	X	__	__	__

Controls

a. Control valves/actuators properly installed.	__	__	X	__	__	__	__	__
b. Control valves/actuators operable.	__	__	X	__	__	__	__	__
c. Dampers/actuators properly installed.	__	__	X	__	__	__	__	__
d. Dampers/actuators operable.	__	__	X	__	__	__	__	__
e. Verify proper location and installation of thermostat.	__	__	X	__	__	__	__	__

Testing, Adjusting, and Balancing (TAB)

a. Construction filters removed and replaced.	__	__	X	__	X	__	__	__
b. TAB results +10%/-0% cfm shown on drawings.	__	__	X	__	X	__	__	__
c. TAB Report submitted.	__	__	X	__	X	__	__	__

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Pumps

For Pump: All

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON \_\_\_\_\_ AUTO \_\_\_\_\_ OFF \_\_\_\_\_

a. Verify pressure drop across strainer:

Strainer inlet pressure \_\_\_\_\_ psig  
 Strainer outlet pressure \_\_\_\_\_ psig

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

	DESIGN	SYSTEM TEST	ACTUAL
Pump inlet pressure (psig)	_____	_____	_____
Pump outlet pressure (psig)	_____	_____	_____

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (gpm)	_____	_____

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (psig)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (gpm)	_____	_____

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____

Functional Performance Test Checklist - Pumps

For Pump: All

Voltage to ground \_\_\_\_\_

b. Minimum flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

3. Unusual vibration, noise, etc.

\_\_\_\_\_  
\_\_\_\_\_

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

Functional Performance Test Checklist - VAV Terminals

The Contracting officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed 10.

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Functional Performance Test Checklist - VAV Terminals

Maximum flow                    cfm  
 Minimum flow                    cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting            cfm  
 Minimum flow setting            cfm

b. Cooling with reheat VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow                    cfm  
 Minimum flow                    cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting            cfm  
 Minimum flow setting            cfm

Reheat coil operation range (full open to full closed) \_\_\_\_\_

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via set point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point. \_\_\_\_\_ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation. \_\_\_\_\_

(2) Check primary air damper maximum/minimum flow settings.

Maximum flow setting            cfm  
 Minimum flow setting            cfm

(3) Check blower fan flow.                    cfm

(4) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register).

(5) Verify that no recirculated air is being induced when box is in full cooling. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Functional Performance Test Checklist - VAV Terminals

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply fan operating mode is initiated:

(1) All dampers in normal position

\_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

(4) VAV fan controller shall "soft-start" fan. \_\_\_\_\_

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the design static pressure Class shown.

\_\_\_\_\_

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper at minimum position]. \_\_\_\_\_

(4) Chilled water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.

\_\_\_\_\_

c. Occupied mode of operation - economizer energized.

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

(1) Outside air damper modulated to maintain mixed air temperature set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(4) Hot water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point. \_\_\_\_\_

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the supply and return fans off mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling.

Supply air volume \_\_\_\_\_ cfm) Max cooling Min cooling  
\_\_\_\_\_

Supply air temp. (\_\_\_\_\_ degrees F) \_\_\_\_\_

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: All

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply fan operating mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper at minimum position . \_\_\_\_\_

(4) Chilled water control valve modulating to maintain space cooling temperature set point. \_\_\_\_\_

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. \_\_\_\_\_

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain space cooling temperature set point. \_\_\_\_\_

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: All

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the supply fan off mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point. \_\_\_\_\_

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: All

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: All  
 chiller start sequence as follows.

- a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. \_\_\_\_\_
- b. Verify control system energizes chiller start sequence. \_\_\_\_\_
- c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_
- d. Verify functioning of "soft start" sequence. \_\_\_\_\_
- e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_
- f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. \_\_\_\_\_

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

	DESIGN	SYSTEM TEST	ACTUAL
Chiller inlet pressure (psig)	_____	_____	_____
Chiller outlet pressure (psig)	_____	_____	_____

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

4. Record the following information:

Ambient dry bulb temperature \_\_\_\_\_ degrees F  
 Ambient wet bulb temperature \_\_\_\_\_ degrees F  
 Entering chilled water temperature \_\_\_\_\_ degrees F  
 Leaving chilled water temperature \_\_\_\_\_ degrees F

5. Unusual vibration, noise, etc.  
 \_\_\_\_\_  
 \_\_\_\_\_

6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: All

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Hot Water Boiler

For Boiler:

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes boiler start sequence. \_\_\_\_\_

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. \_\_\_\_\_

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

	DESIGN	SYSTEM TEST	ACTUAL
Boiler inlet pressure (psig)	_____	_____	_____
Boiler outlet pressure (psig)	_____	_____	_____
Boiler flow rate (gpm)	_____	_____	_____
Flue-gas temperature at boiler outlet	_____	_____	_____
Percent carbon dioxide in flue-gas	_____	_____	_____
Draft at boiler flue-gas exit	_____	_____	_____
Draft or pressure in furnace	_____	_____	_____
Stack emission pollutants	_____	_____	_____

Functional Performance Test Checklist - Hot Water Boiler

For Boiler:

concentration

Fuel type

Combustion efficiency

\_\_\_\_\_

3. Record the following information:

Ambient temperature

Entering hot water temperature

Leaving hot water temperature

\_\_\_\_\_ degrees F  
\_\_\_\_\_ degrees F  
\_\_\_\_\_ degrees F

4. Verify temperatures in item 3 are in accordance with the reset schedule. \_\_\_\_\_

5. Verify proper operation of boiler safeties. \_\_\_\_\_

6. Unusual vibration, noise, etc.  
\_\_\_\_\_  
\_\_\_\_\_

7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. \_\_\_\_\_

8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

Functional Performance Test Checklist - Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 2.

Functional Performance Test Checklist - Unit Heaters

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. \_\_\_\_\_

b. Check blower fan speed. \_\_\_\_\_ rpm

c. Check heating mode inlet air temperature. Check heating mode inlet air temperature. \_\_\_\_\_ degrees F

d. Check heating mode outlet air temperature. Check heating mode outlet air temperature. \_\_\_\_\_ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - HVAC Controls

For HVAC System: All

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10.

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Functional Performance Test Checklist - HVAC Controls

For HVAC System: All

Sensor \_\_\_\_\_  
Manual measurement \_\_\_\_\_  
Panel reading value \_\_\_\_\_

c. Verify system stability by changing the controller set point as follows:

- (1) Air temperature - 10 degrees F
- (2) Water temperature - 10 degrees F
- (3) Static pressure - 10 percent of set point
- (4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

- d. Verify interlock with other HVAC controls.
- e. Verify interlock with fire alarm control panel.
- f. Verify interlock with EMCS.

g. Change controller set point 10 percent with EMCS and verify correct response.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contractor's Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

-- End of Section --

## SECTION 16070

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT  
04/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 580 (1996) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint

CORPS OF ENGINEERS, HUNTSVILLE ENGINEERING AND SUPPORT CENTER  
(CEHNC)

TI 809-04 (1998) Seismic Design for Buildings

## UNDERWRITERS LABORATORIES (UL)

UL 1570 (1995; Rev thru Feb 1999) Fluorescent Lighting Fixtures

UL 1571 (1995; Rev thru Feb 1999) Incandescent Lighting Fixtures

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Lighting Fixtures in Buildings; G, AE.

Equipment Requirements; G, AE.

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

## SD-03 Product Data

Lighting Fixtures in Buildings; G, AE.

Equipment Requirements; G, AE.

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing; G, AE.

Copies of the Design Calculations with the Drawings. Calculations shall be approved, certified, stamped and signed by a Registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the electrical equipment and systems listed below. Structural requirements shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

#### 1.3.2 Electrical Equipment

Electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Control Panels	Air Handling Units
Pumps with Motors	Switchgear
Light Fixtures	Unit Substations
Transformers	Uninterruptable Power Supplys
Switchboards (Floor Mounted)	Storage Racks
Generators	

#### 1.3.3 Electrical Systems

All electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

#### 1.3.4 Contractor Designed Bracing

The Contractor shall design the bracing where required in accordance with TI 809-04 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. TI 809-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using TI 809-04 are based on strength design; therefore, the AISC LRFP specifications shall be used for the design.

#### 1.3.5 Conduits Requiring No Special Seismic Restraints

Seismic restraints may be omitted from electrical conduit less than 2-1/2 inches trade size . All other interior conduit, shall be seismically protected as specified.

## 1.4 EQUIPMENT REQUIREMENTS

### 1.4.1 Rigidly Mounted Equipment

The following specific items of equipment: shall be constructed and assembled to withstand the seismic forces specified in TI 809-04, Chapter 10. Each item of rigid electrical equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

- Engine-Generators
- Substations
- Transformers
- Switchboards and Switchgear
- Uninterruptable Power Supplies
- Free Standing Electric Motors

### 1.4.2 Nonrigid or Flexibly-Mounted Equipment

Electrical equipment shall be constructed and assembled to resist a horizontal lateral force of 3 times the operating weight of the equipment at the vertical center of gravity of the equipment.

## PART 2 PRODUCTS

### 2.1 LIGHTING FIXTURE SUPPORTS

Lighting fixtures and supports shall conform to UL 1570 or UL 1571 as applicable.

### 2.2 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

## PART 3 EXECUTION

### 3.1 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe in accordance with Section 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

### 3.2 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

#### 3.2.1 Pendant Fixtures

Pendant fixtures shall conform to the requirements of TI 809-04, Chapter 10.

#### 3.2.2 Ceiling Attached Fixtures

##### 3.2.2.1 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system built in accordance with ASTM E 580. Seismic protection for the fixtures shall

conform to the requirements of TI 809-04, Chapter 10. Recessed lighting fixtures not over 56 pounds in weight may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

#### 3.2.2.2 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system built in accordance with ASTM E 580. Seismic protection for the fixtures shall conform to the requirements of TI 809-04, Chapter 10.

#### 3.2.3 Assembly Mounted on Outlet Box

A supporting assembly, that is intended to be mounted on an outlet box, shall be designed to accommodate mounting features on 4 inch boxes, plaster rings, and fixture studs.

#### 3.2.4 Lateral Force

Structural requirements for light fixture bracing shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANIOUS EQUIPMENT.

-- End of Section --

SECTION 16175

ANALOG ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM

**TEMPLATE ONLY FOR TABLE OF CONTENTS**

PART 1 GENERAL

PART 2 PRODUCTS

PART 3 EXECUTION

-- End of Section --

16261

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS  
09/99

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 519 (1992) Harmonic Control in Electrical Power Systems

IEEE C62.41 (1991) Surge Voltages in Low-Voltage AC Power Circuits

## U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461 (Rev. D) Control of Electromagnetic Interference Emissions and Susceptibility

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ICS 3.1 (1990) Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

NEMA ICS 7 (1993) Industrial Control and Systems Adjustable-Speed Drives

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 489 (1996; R 1998) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures

UL 508C (1996) Power Conversion Equipment

## 1.2 RELATED REQUIREMENTS

SECTION 16415 "Electrical Work,Interior" apply to this section with additions and modifications specified herein.

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 Performance Requirements

##### 1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

##### 1.3.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

#### 1.3.2 Electrical Requirements

##### 1.3.2.1 Power Line Surge Protection

IEEE C62.41, IEEE Std 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

##### 1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

- a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Schematic diagrams; G, AE.

Interconnecting diagrams; G, AE.

Installation drawings; G, AE.

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

#### SD-03 Product Data

Variable frequency drives; G, AE.

Wires and cables

Equipment schedule

Include data indicating compatibility with motors being driven. G, AE.

#### SD-06 Test Reports

VFD Test G.

Performance Verification Tests G.

Endurance Test G.

#### SD-08 Manufacturer's Instructions

Installation instructions

#### SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; G.

Factory test results

#### SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Submit operation and maintenance manuals within 7 days following completion of tests. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for

government maintenance personnel to verify proper operation of the functional assemblies.

#### 1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

#### 1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

#### 1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

#### 1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

#### 1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

### 1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

### 1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

### 1.8 MAINTENANCE

#### 1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

### 1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

## PART 2 PRODUCTS

### 2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

- a. Input circuit breaker per UL 489 with a minimum of 50,000 amps symmetrical interrupting capacity and door interlocked external operator.
- b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.
- c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.
- d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.
- e. The VFD shall be designed to operate from a 480 volts (or the corresponding motor input voltage), + or - 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.
- f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.
- g. Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

- h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.
- i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.
- j. The controller efficiency at any speed shall not be less than 96 percent.
- k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.
- l. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:
  - 1. Short circuit at controller output
  - 2. Ground fault at controller output
  - 3. Open circuit at controller output
  - 4. Input undervoltage
  - 5. Input overvoltage
  - 6. Loss of input phase
  - 7. AC line switching transients
  - 8. Instantaneous overload
  - 9. Sustained overload exceeding 115 percent of controller rated current
  - 10. Over temperature
  - 11. Phase reversal
- m. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.
- n. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within + / - 0.5 percent of maximum speed without the necessity of a tachometer generator.
- o. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent, undervoltage,

overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

- p. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.
- q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.
- r. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:
  - 1. Manual speed potentiometer.
  - 2. Hand-Off-Auto ( HOA ) switch.
  - 3. Power on light.
  - 4. Drive run power light.
  - 5. Local display.
- s. Provide properly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of VFD failure. Mechanical and electrical interlocks shall be installed between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer.

## 2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

## 2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

## 2.4 NAMEPLATES

Nameplates external to NEMA enclosures shall conform with the requirements of division 16. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

## 2.5 SOURCE QUALITY CONTROL

### 2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

### 3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

#### 3.2.1 VFD Test

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

#### 3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

#### 3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

### 3.3 DEMONSTRATION

#### 3.3.1 Training

Coordinate training requirements with the Contracting Officer.

##### 3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified herein. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

#### 3.3.1.2 Operating Personnel Training Program

Provide one 2 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 2 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

- a. System overview
- b. General theory of operation
- c. System operation
- d. Alarm formats
- e. Failure recovery procedures
- f. Troubleshooting

#### 3.3.1.3 Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a 1/8 day (1 hour) training session to train 2 maintenance personnel in the functional operations of the system. This training shall include:

- a. System overview
- b. General theory of operation
- c. System operation
- d. System configuration
- e. Alarm formats
- f. Failure recovery procedures

- g. Troubleshooting and repair
  - h. Maintenance and calibration
  - i. System programming and configuration
- End of Section --

## SECTION 16263

DIESEL-GENERATOR SET STATIONARY 1500 KW, WITH AUXILIARIES, EACH SET  
**06/02**

## PART 1 GENERAL

## 1.1 RELATED REQUIREMENTS

Section 16415, "ELECTRICAL WORK, INTERIOR," and Section 16442, "MAIN OUTDOOR WALKIN SWITCHGEAR" applies to this section with the additions and modifications specified herein.

## 1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.11 (1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M (1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 106 (1999e1) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 181/A 181M (2000) Carbon Steel Forgings for General-Purpose Piping

ASTM A 234/A 234M (2000) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

ASTM D 975 (1998b) Diesel Fuel Oils

## ASME INTERNATIONAL (ASME)

ASME B16.3 (1998) Malleable Iron Threaded Fittings

ASME B16.5 (1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24

ASME B16.11 (1996) Forged Fittings, Socket-Welding and Threaded

ASME B31.1 (1998) Power Piping

ASME BPVC SEC VIII D1 (1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASME BPVC SEC IX (1998) Boiler and Pressure Vessel Code;  
Section IX, Welding and Brazing  
Qualifications

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P (1995a) Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

IEEE C57.13.1 (1981; R 1992) IEEE Guide for Field Testing  
of Relaying Current Transformers

IEEE Std 1 (1986; R 1992) General Principles for  
Temperature Limits in the Rating of  
Electric Equipment and for the Evaluation  
of Electrical Insulation

IEEE Std 43 (1974; R 1991) Testing Insulation  
Resistance of Rotating Machinery

IEEE Std 81 (1983) Guide for Measuring Earth  
Resistivity, Ground Impedance, and Earth  
Surface Potentials of a Ground System (Part  
1)

IEEE Std 100 (1997) IEEE Standard Dictionary of  
Electrical and Electronics Terms

IEEE Std 115 (1995) IEEE Guide: Test Procedures for  
Synchronous Machines

IEEE Std 120 (1989) Electrical Measurements in Power  
Circuits

IEEE Std 484 (1996) Recommended Practice for  
Installation Design and Installation of  
Vented Lead-Acid Batteries for Stationary  
Applications

IEEE Std 485 (1997) Recommended Practice for Sizing  
Large Lead Storage Batteries for Generating  
Stations and Substations

IEEE Std 519 (1992) Harmonic Control in Electrical Power  
systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports -  
Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports -  
Selection and Application

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

NEMA MG 1 (1998) Motors and Generators

NEMA PB 1 (1995) Panelboards

NEMA PB 2 (1995) Deadfront Distribution Switchboards

NEMA SG 5 (1995) Power Switchgear Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30 (1996; Errata; TIA 96-2) Flammable and Combustible Liquids Code

NFPA 37 (1998) Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 70 (1999) National Electrical Code

NFPA 99 (1999) Health Care Facilities

NFPA 110 (1999) Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 537 (1996) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 1236 (1994; Rev thru Mar 1999) Battery Chargers for Charging Engine-Starter Batteries

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout; G.  
General Installation; G.

Drawings shall include the following:

- a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.
- b. Complete starting system.
- c. Complete fuel system.
- d. Complete cooling system.
- e. Complete exhaust system.
- f. Layout of relays, breakers, programmable controllers, switchgear, and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.
- g. The complete lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil and turbocharger cooling, electric heater, controls and wiring.
- h. Location, type, and description of vibration isolation devices for all applications.
- i. The safety system, together with a detailed description of how it is to work. Wiring schematics, safety devices with a listing of their normal ranges, alarm and shutdown values (to include operation parameters such as pressures, temperatures voltages, currents, and speeds) shall be included.
- j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.
- k. Layout of each panel.
- l. Mounting and support for each panel and major piece of electrical equipment.
- m. Engine-generator set lifting points and rigging instructions.
- n. Generator Weatherproof Enclosure, complete details
- o. Paralleling controls and interfacing.

Acceptance; G.

Drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Layout drawings shall be revised to reflect the as-built conditions and shall be submitted with the as-built drawings.

SD-03 Product Data

Performance Criteria; G.

Calculations of the engine and generator output power capability,

including efficiency and parasitic load data.

Sound Limitations; G.

Sound power level data for the packaged unit operating at 100% load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification.

Harmonic Requirements; G.

Engine-Generator Parameter Schedule; G.

Description of the generator features which mitigate the effects of the non-linear loads listed.

Integral Main Fuel Storage Tank; G.

Day Tank; G.

Calculations for the capacity of each day tank, including allowances for recirculated fuel, usable tank capacity, and duration of fuel supply.

Power Factor; G.

The generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0.

Heat Rejected To Engine-Generator Space; G.

Manufacturers data to quantify heat rejected to the space with the engine generator set at rated capacity.

Cooling System; G.

A letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified.

- a. The maximum allowable inlet temperature of the coolant fluid.
- b. The minimum allowable inlet temperature of the coolant fluid.
- c. The maximum allowable temperature rise in the coolant fluid through the engine.

Time-Delay on Alarms; G.

The magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels.

Generator; G.

Manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

Direct-Axis subtransient reactance (per unit).

The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

Manufacturer's Catalog; G.

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

Site Welding;

A copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators.

A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

Spare Parts;

A complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Each list shall be separated into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements.

Onsite Training;

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

Battery Charger;

Battery charger sizing calculations.

Vibration-Isolation; G,

Vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

Posted Data and Instructions;

Posted data including wiring and control diagrams showing the key mechanical and electrical control elements, and a complete layout of the entire system.

Instructions; G,

Instructions including: the manufacturers pre-start checklist

and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, and load-shedding). Instructions shall be weatherproof, laminated in plastic, and posted where directed.

Experience;

Each component manufacturer has a minimum of 5 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler has a minimum of 5 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

Field Engineer;

A letter listing the qualifications, schools, formal training, and experience of the field engineer.

General Installation; G,

A copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure.

SD-06 Test Reports

Factory Inspection and Tests; .

Six complete reproducible copies of the factory inspection result on the checklist format specified in paragraph FACTORY INSPECTION AND TESTS.

Factory Tests;

a. A letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

c. Six copies of the Factory Test data described below in 8-1/2 x 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 x 11 inch minimum), showing grid lines, with full resolution.

- (1) A detailed description of the procedures for factory tests.
- (2) A list of equipment used, with calibration certifications.
- (3) A copy of measurements taken, with required plots and graphs.

- (4) The date of testing.
- (5) A list of the parameters verified.
- (6) The condition specified for the parameter.
- (7) The test results, signed and dated.
- (8) A description of adjustments made.

Onsite Inspection and Tests;

a. A letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least 21 days prior to beginning tests.

c. Six copies of the onsite test data described below in 8-1/2 x 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 x 11 inch minimum), showing grid lines, with full resolution.

- (1) A detailed description of the procedures for onsite tests.
- (2) A list of equipment used, with calibration certifications.
- (3) A copy of measurements taken, with required plots and graphs.
- (4) The date of testing.
- (5) A list of the parameters verified.
- (6) The condition specified for the parameter.
- (7) The test results, signed and dated.
- (8) A description of adjustments made.

SD-07 Certificates

Vibration Isolation;

Torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds,  $\pm 10\%$ .

Prototype Test;

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

Reliability and Durability;

A reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

Emissions;

A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HPAs).

Sound Limitations;

A certification from the manufacturer stating that the sound emissions meet the specification.

Site Visit;

A letter stating the date the site was visited and listing discrepancies found.

Flywheel Balance;

A certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125% of rated speed without vibration or damage.

Materials and Equipment;

A certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

Inspections;

A letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

#### Cooling System;

Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

#### SD-10 Operation and Maintenance Data

##### Operation and Maintenance Manuals;

Six copies of the operation manual (approved prior to commencing onsite tests) in 8-1/2 x 11 inch binders, having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each system or subsystem. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8-1/2 x 11 inch plastic pockets with reinforced holes. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual shall include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. Each booklet shall include a CDROM containing an ASCII and/or MS word format file of the procedures.

##### Maintenance Procedures;

Six copies of the maintenance manual containing the information described below in 8-1/2 x 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each item listed. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

- a. Procedures for each routine maintenance item.

Procedures for troubleshooting.

Factory-service, take-down overhaul, and repair service manuals, with parts lists.

- b. A copy of the posted instructions.

- c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates.

Six complete reproducible copies of the final relay and protective device settings. The settings shall be recorded with the name of the company and individual responsible for their accuracy.

##### Special Tools;

Two complete sets of special tools required for maintenance

(except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable tool box. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings.

#### Filters;

Two complete sets of filters, required for maintenance, shall be supplied in a suitable storage box. These filters shall be in addition to filters replaced after testing.

### 1.4 SYSTEM DESCRIPTION

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

#### 1.4.1 Engine-Generator Parameter Schedule

##### ENGINE-GENERATOR PARAMETER SCHEDULE

Power Rating	Emergency Standby
Overload Capacity (Prime applications only)	110% of half of Service Load or 1650 KW whichever is higher for 1 hour in 12 consecutive hours
Service Load	3000 kVA (maximum) 2800 kVA (continuous)
Motor Starting kVA (Max.)	4400 kVA
Power Factor	0.8 lagging
Engine-Generator Applications	stand-alone and parallel with infinite bus and parallel with other generators on an isolated bus and parallel with other generators on an infinite bus
Maximum Speed	1800 rpm
Heat Exchanger Type	fin-tube (radiator)
Governor Type	Isochronous
Frequency Bandwidth (steady state)	+ 0.25 %
Voltage Regulation (No Load to Full Load) (Stand alone applications)	+ 2% (maximum)

## ENGINE-GENERATOR PARAMETER SCHEDULE

Voltage Bandwidth (steady state)	+ 1 %
Frequency	60 Hz
Voltage	480Y/277 volts
Phases	3 Phase, Wye
Minimum Generator Subtransient Reactance	12 %
Nonlinear Loads	1200 kVA
Max Step Load Increase	100 % of Service Load at .8 PF
Transient Recovery Time with Step Load Increase (Voltage)	10 seconds
Transient Recovery Time with Step Load Increase (Frequency)	10 seconds
Maximum Voltage Deviation with Step Load Increase	10 % of rated voltage
Maximum Frequency Deviation with Step Load Increase	5 % of rated frequency
Max Step Load Decrease (without shutdown)	100 % of Service Load at .8 PF
Max Time to Start and be Ready to Assume Load	10 seconds
Max Summer Indoor Temp (Prior to Genset Operation)	50 degrees celcius
Min Winter Indoor Temp (Prior to Genset Operation)	-10 degrees celcius
Max Summer Outdoor Temp (Ambient)	50 degrees
Min Winter Outdoor Temp (Ambient)	-10 degrees
Installation Elevation	100 feet above sea level

## 1.4.2 Rated Output Capacity

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

### 1.4.3 Power Ratings

Power ratings shall be in accordance with EGSA 101P.

### 1.4.4 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

### 1.3.5 Reliability and Durability

Each prime engine-generator set shall have both an engine and a generator capable of delivering the specified power on a prime basis with an anticipated mean time between overhauls of not less than 10,000 hours operating with a 70% load factor. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent from the physical location of the manufacturer's and assembler's facilities. The engine and generators should have been in operation for a minimum of 8000 actual hours at a minimum load of 70% of the rated output capacity. During two consecutive years of service, the units should not have experienced any failure resulting in a downtime in excess of 72 hours. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

## 1.5 GENERAL REQUIREMENTS

### 1.5.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified in paragraph SUBMITTALS.

### 1.5.2 Nameplates

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engines	Relays
Generators	Transformers (CT & PT)
Regulators	Day tanks
Pumps and pump motors	Governors
Generator Breaker	Air Starting System
Economizers	Heat exchangers (other than base)

mounted)

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Switchboards	Exhaust mufflers
Switchgear	Silencers
Battery	Exciters

#### 1.5.3 Personnel Safety Devices

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

#### 1.5.4 Verification of Dimensions

**Before performing any work, the premises shall be visited and all details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies.**

#### 1.5.5 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

#### 1.5.6 Site Welding

For all other welding, procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Welder qualification tests shall be performed for each welder whose qualifications are not in compliance with the referenced standards. The Contracting Officer shall be notified 72 hours in advance of qualification tests. The qualification tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

#### 1.5.7 Parallel Operation

Paralleling controls shall be provided in the main outdoor switch. Coordinate with section 16442 and provide paralleling controls specified and indicated. Each engine-generator set specified for parallel operation shall be configured for automatic and manual parallel operation. Each set shall be capable of parallel operation with a commercial power source on an infinite bus and one or more sets on an isolated bus and a commercial power source on an infinite bus and with one or more sets.

#### 1.5.8 Load Sharing

Each engine-generator set specified for parallel operation shall be configured to manually load share with other sets and automatically load share with other sets by proportional loading. Proportional loading shall

load each set to within 5% of its fair share. A set's fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line sets. Load sharing shall incorporate both the real and reactive components of the load.

#### 1.5.9 Engine-Generator Set Enclosure

The engine-generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Fully hinged panels and doors shall be provided for access to components requiring periodic replacement.

The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system. The enclosure shall reduce the noise of the generator set to within the limits specified in the paragraph SOUND LIMITATIONS.

#### 1.5.10 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 6 mils (peak-peak RMS), with an overall velocity limit of 0.95 inches/second RMS, for all speeds through 110% of rated speed.

#### 1.5.11 Vibration Isolation

The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation. Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic parameters specified.

#### 1.5.12 Seismic Requirements

Seismic requirements shall be in accordance with Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT .

#### 1.5.13 Harmonic Requirements

Non-linear loads to be served by each engine-generator set is 1200 KVA at a K-factor of K-13.

#### 1.5.14 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be transferred within the starting time specified.

#### 1.5.15 Experience

Each component manufacturer shall have a minimum of 5 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler shall have a minimum of 5 years

experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

#### 1.5.16 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets.

### 1.6 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment, in accordance with the manufacturers recommended storage procedures, before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

#### 2.1.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

#### 2.1.2 Instrument Transformers

ANSI C12.11.

#### 2.1.3 Pipe (Sleeves, Fuel/Lube-Oil, Compressed Air, Coolant, and Exhaust)

ASTM A 53/A 53M, or ASTM A 106 steel pipe. Pipe smaller than 2 inches shall be Schedule 80. Pipe 2 inches and larger shall be Schedule 40.

- a. Flanges and Flanged Fittings: ASTM A 181/A 181M, Class 60, or ASME B16.5, Grade 1, Class 150.
- b. Pipe Welding Fittings: ASTM A 234/A 234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.
- c. Threaded Fittings: ASME B16.3, Class 150.
- d. Valves: MSS SP-80, Class 150.
- e. Gaskets: Manufacturer's standard.

#### 2.1.4 Pipe Hangers

MSS SP-58 and MSS SP-69.

#### 2.1.5 Electrical Enclosures

NEMA ICS 6.

#### 2.1.5.1 Power Switchgear Assemblies

NEMA SG 5.

#### 2.1.5.2 Switchboards

NEMA PB 2.

#### 2.1.5.3 Panelboards

NEMA PB 1.

#### 2.1.6 Electric Motors

Electric motors shall conform to the requirements of NEMA MG 1. Motors shall have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors shall have drip-proof frames; those used outside shall be totally enclosed. Alternating current motors larger than 1/2 Hp shall be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, shall be suitable for operation on 120 volts, 60 Hz, and single-phase power.

#### 2.1.7 Motor Controllers

Motor controllers and starters shall conform to the requirements of NFPA 70 and NEMA ICS 2.

### 2.2 ENGINE

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor.

### 2.3 FUEL SYSTEM

The entire fuel system for each engine-generator set shall conform to the requirements of NFPA 30 and NFPA 37 and contain the following elements.

#### 2.3.1 Pumps

##### 2.3.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

##### 2.3.1.2 Auxiliary Fuel Pump

Auxiliary fuel pumps shall be provided to maintain the required engine fuel pressure, as required by the installation and manufacturers recommendation. The auxiliary pump shall be automatically actuated by a pressure-detecting device.

#### 2.3.2 Fuel Filter

A minimum of one full-flow fuel filter shall be provided for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

#### 2.3.3 Relief/Bypass Valve

A relief/bypass valve shall be provided to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

#### 2.3.4 Day Tank

Each engine shall be provided with integral day tank. Each day tank shall be provided with connections for fuel supply line, fuel return line, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the day tank shall be below the flash point of the fuel. A temperature sensing device shall be installed in the fuel supply line, . Each engine-generator set provided with weatherproof enclosures shall have its day tank mounted within the enclosure. The fuel fill line shall be accessible without opening the enclosure.

##### 2.3.4.1 Capacity, Standby

Each day tank shall have capacity to supply fuel to the engine for an uninterrupted 8-hour period at 100% rated load without being refilled, plus any fuel which may be returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90% of the ultimate volume of the tank.

##### 2.3.4.2 Drain Line

Each day tank drain line shall be accessible and equipped with a shutoff valve. Self-supporting day tanks shall be arranged to allow drainage into a 12 inch tall bucket.

##### 2.3.4.3 Local Fuel Fill

Each local fuel fill port on the day tank shall be provided with a screw-on cap.

##### 2.3.4.4 Fuel Level Controls

- a. Each day tank shall have a float-switch assembly to perform the following functions:

- (1) Start the supply of fuel into the day tank when the fuel level is at the "Low" level mark, 75% of the rated tank capacity.

(2) Stop the supply of fuel into the day tank when the fuel level is at 90% of the rated tank capacity.

(3) Activate the "Overfill Fuel Level" alarm at 95% of the rated tank capacity.

(4) Activate the "Low Fuel Level" alarm at 70% of the rated tank capacity.

(5) Activate the automatic fuel supply shut-off valve located on the fill line of the day tank and shut down the fuel pump which supplies fuel to the day tank at 95% of the rated tank capacity. The flow of fuel shall be stopped before any fuel can be forced into the fuel overflow line.

#### 2.3.4.5 Arrangement

Integral day tanks may allow gravity flow into the engine. Gravity flow tanks shall be provided with an internal or external valve located as near as possible to the shell of the tank. The valve shall close when the engine is not operating. Integral day tanks shall be provided with all necessary pumps to supply fuel to the engine as recommended by the generator set manufacturer. The overflow connection and the fuel supply line for integral day tanks which do not rely upon gravity flow shall be arranged so that the highest possible fuel level is below the fuel injectors. When the main fuel storage tanks are located below the day tank, a check valve shall be provided in the fuel supply line entering the day tank. When the main fuel storage tanks are located above the day tank, a solenoid valve shall be installed in the fuel supply line entering the day tank. The solenoid valve shall be in addition to the automatic fuel shut off valve. The fuel supply line from the day tank to the manufacturer's standard engine connection shall be welded pipe.

#### 2.3.5 Fuel Supply System

The fuel supply from the main storage of fuel to the day tank shall be as specified in Section 13210 ABOVEGROUND FUEL OIL STORAGE TANKS.

### 2.4 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase for closed systems. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

#### 2.4.1 Lube-Oil Filter

One full-flow filter shall be provided for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

#### 2.4.2 Lube-Oil Sensors

Each engine shall be equipped with lube-oil pressure sensors. Pressure sensors shall be located downstream of the filters and provide signals for required indication and alarms.

#### 2.4.3 Precirculation Pump

A motor-driven precirculation pump powered by the station battery, complete with motor starter shall be provided if recommended by the engine manufacturer.

### 2.5 COOLING SYSTEM

Each engine shall have its own cooling system. Each system shall operate automatically while its engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine shall not exceed that recommended and submitted in paragraph SUBMITTALS.

#### 2.5.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers.

#### 2.5.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted in paragraph SUBMITTALS for the maximum summer outdoor design temperature and site elevation. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of application.

##### 2.5.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via oversizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 7 psi and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged.

#### 2.5.3 Expansion Tank

The cooling system shall include an air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those

components. The tank shall be suitable for operating temperature of 250 degrees F and a working pressure of 125 psi. The tank shall be constructed of welded steel, tested and stamped in accordance with ASME BPVC SEC VIII D1 for the stated working pressure. A bladder type tank shall not be used. The tank shall be supported by steel legs or bases for vertical or steel saddles for horizontal installation.

#### 2.5.4 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

#### 2.5.5 Ductwork

Ductwork shall be in accordance with NFPA and as recommended by the manufacturer.

#### 2.5.6 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

### 2.6 SOUND LIMITATIONS

The noise generated by the diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field outside of the weatherproof enclosure, at a radial distance of 22.9 feet at 45 degrees apart in all directions.

Frequency Band (Hz)	Maximum Acceptable Pressure Level (Decibels)
31	60
63	69
125	82
250	78
500	82
1,000	82
2,000	76
4,000	65
8,000	90

The noise generated by the installed diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured at a distance of 35 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 35 feet from the engine at 45 degrees apart in all directions for vertical piping.

Frequency Band (Hz)	Maximum Acceptable Pressure Level (Decibels)
31	78
63	78
125	78
250	78
500	78
1,000	78
2,000	78
4,000	78
8,000	78

## 2.7 AIR INTAKE EQUIPMENT

Filters and silencers shall be provided in locations that are convenient for servicing. The silencer shall be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer.

Silencer shall be capable of reducing the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines shall be copper .

## 2.8 EXHAUST SYSTEM

The system shall be separate and complete for each engine. Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

### 2.8.1 Flexible Sections and Expansion Joints

A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

### 2.8.2 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be constructed of welded steel and designed for outside or inside enclosure mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

### 2.8.3 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers installed inside shall be insulated in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

### 2.9 PYROMETER

A pyrometer, multi-point selector switch, and individual thermocouples with calibrated leads shall be provided to show the temperature in each engine cylinder and the combined exhaust. For a supercharged engine, additional points, thermocouples and leads shall be provided to show the temperature in the turbocharger exhaust gas outlet and combustion air discharge passages. Graduated scale length shall be not less than 6 inches. The selector switch shall be double pole, with an "off" position, one set of points for each thermocouple, and suitable indicating dial. The pyrometer, thermocouples, leads and compensating devices shall be calibrated to show true exhaust temperature within plus or minus 1% above the highest temperature encountered at 110% load conditions.

### 2.10 EMISSIONS

The finished installation shall comply with Federal, state, and local regulations and restrictions regarding the limits of emissions.

### 2.11 STARTING SYSTEM

The starting system for standby engine generator sets used in emergency applications shall be in accordance with NFPA 99 and NFPA 110 and as follows.

#### 2.11.1 Controls

An engine control switch shall be provided with functions including: run/start(manual), off/reset, and, automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cooldown operation. The logic shall be arranged for manual starting and fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

#### 2.11.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

#### 2.11.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground.

##### 2.11.3.1 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. The battery shall be in accordance with SAE J 537. Critical system components (rack, protection, etc.) shall be sized to withstand the seismic acceleration forces specified. The battery shall be lead-acid or nickel-cadmium, with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

#### 2.11.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting.

A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

#### 2.11.4 Starting Aids

The manufacturer shall provide one or more of other following methods to assist engine starting.

##### 2.11.4.1 Glow Plugs

Glow plugs shall be designed to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of minus 25 degrees F.

##### 2.11.4.2 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 or 208 or 480 volts ac.

##### b. Standby Rated Sets

The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

##### 2.11.4.3 Lubricating-Oil Heaters

A thermostatically controlled electric heater shall be mounted in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 or 208 or 480 volts ac.

#### 2.11.5 Exerciser

The exerciser shall be in accordance with Section 16442 MAIN OUTDOOR WALKIN SWITCHGEAR.

## 2.12 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100% of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110% of the rated speed/frequency, over a steady state load range of 0 to 100% or rated capacity.

### 2.12.1 Governor Performance

Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100% of rated output capacity.

## 2.13 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class H. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25% overspeeds, or voltages and temperatures at a rated output capacity of 110% for prime applications and 100% for standby applications. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type.

### 2.13.1 Current Balance

At 100% rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2% of the largest current on either of the 2 phases.

### 2.13.2 Voltage Balance

At any balanced load between 75 and 100% of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1% of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25% load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3% of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25% load for single phase load conditions means 25% of rated current at rated phase voltage and unity power factor.

### 2.13.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10%. The RMS of all harmonics shall be less than 5.0% and that of any one harmonic less than 3.0% of the fundamental at rated output capacity. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE Std 519.

## 2.14 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300% for peak inverse voltage and forward current ratings for all operating conditions, including 110% generator output at 104 degrees F ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified.

## 2.15 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter. The regulator shall maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100% of rated output capacity. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110% of the rated voltage over the steady state load range of 0 to 100% of rated output capacity. Regulation drift shall not exceed plus or minus 0.5% for an ambient temperature change of 68 degrees F. Reactive droop compensation or reactive differential compensation shall load share the reactive load proportionally between sets during parallel operation.

### 2.15.1 Steady State Performance (Regulation or Voltage Droop)

The voltage regulator shall have a maximum droop of 2% of rated voltage over a load range from 0 to 100% of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

## 2.16 GENERATOR ISOLATION AND PROTECTION

Devices necessary for electrical protection and isolation of each engine-generator set and its ancillary equipment shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. The generator circuit breaker shall be electrically operated. A set of surge capacitors, to be mounted at the generator terminals shall be provided. Monitoring and control devices shall be as specified in paragraph GENERATOR PANEL.

## 2.17 SAFETY SYSTEM

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgment and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element.

### 2.17.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

### 2.17.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.17.3 Alarms and Action Logic

2.17.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers shall be accomplished.

2.17.3.2 Problem

Activation of the visual signal shall be accomplished.

2.17.4 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions NFPA 99 NFPA 110 level 1 and including the listed Corps of Engineer requirements mounted either on or adjacent to the engine generator set.

Device/Condition /Function	What/Where/Size	NFPA 99	NFPA 110 Level 1	NFPA 110 Level 2	Corps of Engrs Required
Shutdowns w/Alarms					
High engine temperature	Automatic/jacket/water/cylinder	SD/CP VA	SD/CP VA	SD/CP VA	SD VA
Low lube-oil pressure	Automatic/pressure/level	SD/CP VA	SD/CP VA	SC/CP VA	SD VA
Overspeed Shutdown& Alarm	(110 percent (+ 2 % of rated speed)	SD/CP VA	SD/CP VA	SD/CP VA	SD VA
Overcrank, Failure to start	Automatic/Failure to start when used	SD/CP VA	SD/CP VA SD/CP VA	SD/CP VA SD/CP VA	
Day tank overflow limit indication & transfer pump shutdown (95 % volume)	Automatic/Day Tank/Level				SD (Pump) CP VA
Red emergency stop switch	Manual Switch		SD/CP VA	SD/CP VA	SD VA

Alarms

Device/Condition /Function	What/Where/Size	NFPA 99	NFPA 110 Level 1	NFPA 110 Level 2	Corps of Engrs Required
Day Tank Tank Level	Automatic/Day				CP VA
(Low fuel Limit indication) (70 percent volume remaining)					
Low fuel level	Main tank, 3 hrs remaining	VA/AA	CP VA	CP VA	CP VA
Integral Main Fuel Storage Tank High Fuel Level	95% volume				CP VA
Low Coolant Temperature	jacket water	CP VA	CP VA	CP VA	
Pre-High Temperature	jacket water/ cylinder	CP VA	CP VA	CP VA	CP VA
Pre-Low Lube-oil Pressure		CP VA			CP VA
High battery Voltage			CP VA	CP VA	
Low battery Voltage			CP VA	CP VA	
Battery charger AC Failure	AC supply not available		CP VA	CP VA	
Control switch not in AUTO			CP VA	CP VA	
Low starting Air pressure			CP VA	CP VA	
Low starting hydraulic pressure			CP VA	CP VA	

- SD - Shut Down
- CP - On Control Panel
- VA - Visual Alarm
- AA - Audible Alarm
- O - Optional

2.17.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be

installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.17.6 Remote Alarm Panel

A remote alarm panel shall be provided in accordance with NFPA 110 and as follows.

Device/Condition/Function	What/Where/Size	NFPA 99	NFPA 110 Level 1	NFPA 110 Level 2
Remote annunciator panel	Battery Powered		Alarms	
Loads on genset		VA		
Battery charger malfunction		VA		
Low lube-oil	Pressure/level	VA/AA	AA	AA
Low temperature	Jacket water	VA/AA	AA	AA
High temperature	Jacket water/ cylinder	VA/AA	AA	AA
Low fuel level	Main tank, 3 hrs remaining	VA/AA	AA	AA
Overcrank	Failure to start	VA/AA	AA	AA
Overspeed		VA/AA	AA	AA
Pre-high temperature	Jacket water/ cylinder		AA	
Control switch not in AUTO			AA	
Common alarm contacts for local & remote common alarm			X	X
Audible alarm silencing switch			X	
Air shutdown damper	When used		AA	AA
Common fault alarm			AA	

- X - Required
- SD - Shutdown
- CP - On Control Panel
- VA - Visual Alarm
- AA - Audible Alarm
- O - Optional

2.18 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

2.18.1 Controls

A local control panel shall be provided with controls in accordance with NFPA 110 level 1 and as follows mounted in the outdoor main switchgear.

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2
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Controls

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2
Switch: run/start - off/reset - auto	CP		
Emergency stop switch & alarm	CP		
Lamp test/indicator test	CP	CP VA	CP VA
Common alarm contacts/ fault relay		X	X
Panel lighting	CP		
Audible alarm & silencing/reset switch	CP		
Voltage adjust for voltage regulator	CP		
Pyrometer display w/selector switch	CP		
Remote emergency stop switch		CP VA	CP VA
Remote fuel shutoff switch			
Remote lube-oil shutoff switch			

2.18.2 Engine Generator Set Metering and Status Indication

A local panel shall be provided with devices in accordance with NFPA 110 level 1 and as follows mounted in the outdoor main switchgear.

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2
Genset Status & Metering			
Genset supplying load System ready		CP VA	CP VAO
Engine oil pressure	CP		
Engine coolant temperature	CP		
Engine RPM (tachometer)	CP		
Engine run hours	CP		
Pyrometer display w/selector switch	CP		
AC volts (generator), 3-phase	CP		
AC amps (generator), 3 - phase	CP		
Generator Frequency	CP		
Phase selector switches (amps & volts)	CP		
Watts/kW			
Voltage Regulator Adjustment	CP		

X - Required

CP - On Control Panel

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2
VA - Visual Alarm			
AA - Audible Alarm			
STD- Manufacturers Standard Offering			
O - Optional			

## 2.19 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted in the outdoor main switchgear. Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

### 2.19.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms shall be keyed alike.

### 2.19.2 Electronic

Electronic indicating instruments shall be true RMS indicating instruments, 100% solid state, state-of-the-art, microprocessor controlled to provide specified functions. Control, logic, and function devices shall be compatible as a system, sealed, dust and water tight, and shall utilize modular components with metal housings and digital instrumentation. An interface module shall be provided to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy shall be not less than 98% for unit mounted devices and 99% for control room, panel mounted devices, throughout a temperature range of minus 4 to 158 degrees F. Data display shall utilize LED or back lit LCD. Additionally, the display shall provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height shall be 0.5 inch .

### 2.19.3 Parameter Display

Indication or readouts of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

## 2.20 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; paralleling, and load-sharing for multiple engine-generator sets; and stopping of each engine-generator set after cool-down. Devices shall automatically reset after termination of their function.

### 2.20.1 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 16442 MAIN OUTDOOR WALKIN SWITCHGEAR.

#### 2.20.2 Automatic Paralleling and Loading of Engine-Generator Sets

Paralleling controls shall be provided in the main outdoor switch. Coordinate with section 16442 and provide paralleling controls specified and indicated. An automatic loading system shall be provided to load and unload engine-generator sets in the following sequence: first generator number one then generator number two . The loading system shall monitor the system load and cause additional engine-generator sets to start, synchronize, and be connected in parallel with the system bus with increasing load. Actuation of the additional engine-generator set start logic shall occur when the load exceeds a percentage setpoint of the operating set's rating for a period of approximately 10 seconds. The device shall provide an adjustable setpoint range from 50 to 100%. When the system load falls below the percentage setpoint of the operating set's rating for a period of approximately 15 minutes, the controller shall unload and disconnect engine-generator sets from the system, stopping each engine-generator set after cool-down.

#### 2.21 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set, and synchronization.

#### 2.22 STATION BATTERY SYSTEM

A station battery system shall be provided to include the battery, battery rack, spacers, automatic battery charger and distribution panelboard with overcurrent protection, metering and relaying. Components shall be sized to withstand the seismic acceleration forces specified. The batteries shall have a rated life of 20 years and a manufacturer's 5-year, no cost replacement guarantee.

##### 2.22.1 Battery

The battery shall be lead-acid ornickel-cadmium, sized in accordance with IEEE Std 485 and conform to the requirements of IEEE Std 484. Valve-regulated lead-acid batteries are not acceptable. The battery environment temperature shall range between -10 and 50 degrees. The battery shall be rated for fully required ampere hours at the 8-hour rate.

##### 2.22.2 Battery Capacity

The battery shall be rated for at least 72 ampere hours at the 8-hour rate, and shall have sufficient capacity to serve the following loads without recharging for a period of 12 hours. At the end of the discharge period, the battery shall have the capacity to simultaneously close and trip all the circuit breakers provided, based on a 1-minute load to final voltage of 1.67 volts per cell.

- a. Diesel-generator safety circuits.
- b. Switchgear indicating lights, control relays, protective relays,

and other switchgear dc components as required for 24 hours.

c. Voltage regulator (dc power supplies).

#### 2.22.3 Battery Charger

A current-limiting, 24-volt (120 VAC input) battery charger shall be furnished to automatically recharge the batteries. The charger shall be capable of an equalize charging rate for recharging fully depleted batteries within 8 hours and a floating-charge rate for maintaining the batteries in a fully charged condition. The charger shall be equipped with a low-voltage alarm relay, 0- to 24-hour equalizing timer, an ammeter to indicate charging rate, and necessary circuit breakers. The charger shall conform to the requirements of UL 1236. A battery is considered to be fully depleted when the voltage falls to a level incapable of operating the equipment loads served by the battery.

#### 2.23 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the affects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

#### 2.24 THERMAL INSULATION

Thermal insulation shall be required by NFPA and as recommended by the manufacturer.

#### 2.25 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted "Langley Brown" in accordance with Langley Air Force Base requirements. .

#### 2.26 FACTORY INSPECTION AND TESTS

The factory tests shall be performed on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Each engine-generator set shall be run not less than 1 hour at rated output capacity prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. Engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package shall be used for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

##### 2.26.1 Factory Inspection

Inspections shall be performed prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and any item found to be in need of correction shall be noted as a necessary repair.

The following checklist shall be used for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
1. Drive belts			
2. Governor and adjustments			
3. Engine timing mark			
4. Starting motor			
5. Starting aids			
6. Coolant type and concentration			
7. Radiator drains			
8. Block coolant drains			
9. Coolant fill level			
10. All coolant line connections			
11. All coolant hoses			
12. Combustion air filter			
13. Combustion air silencer			
14. Lube oil type			
15. Lube oil sump drain			
16. Lube-oil filter			
17. Lube-oil-level indicator			
18. Lube-oil-fill level			
19. All lube-oil line connections			
20. All lube-oil lines			
21. Fuel type and amount			
22. All fuel-line connections			
23. All fuel lines			
24. Fuel filter			
25. Coupling and shaft alignment			
26. Voltage regulators			
27. Battery-charger connections			
28. All wiring connections			
29. Instrumentation			
30. Hazards to personnel			
31. Base			
32. Nameplates			
33. Paint			
34. Exhaust-heat recovery unit			

#### 2.26.2 Factory Tests

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be the power factor specified in the engine generator set parameter schedule. Electrical measurements shall be performed in accordance with IEEE Std 120.

Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE Std 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

- a. Insulation Resistance for Stator and Exciter Test, IEEE Std 115 and IEEE Std 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

- b. High Potential Test, per IEEE Std 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.
- c. Winding Resistance Test, Stator and Exciter, per IEEE Std 115. Generator manufacturer's production line test is acceptable.
- d. Overspeed Vibration Test, per IEEE Std 115 to the performance criteria in NEMA MG 1. The test shall be performed at 110% of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.
- e. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.
  - (1) Start and operate the generator at no load.
  - (2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.
  - (3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
  - (4) Apply 75% rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
  - (5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
  - (6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.
- f. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 % of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.
- g. Voltage Waveform Deviation and Distortion Test per IEEE Std 115 to the performance criteria specified in paragraph GENERATOR. High-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion shall be used. Representation of results shall include appropriate scales to provide a means to measure and interpret results.
- h. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:
  - (1.) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.
  - (2.) Increase load to Rated Output Capacity. Record the generator

output frequency and line-line and line-neutral voltages.

3. Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop \%} = \frac{(\text{No-Load Volts}) - (\text{Rated Capacity volts})}{(\text{Service-Load Volts})} \times 100$$

$$\text{Frequency droop \%} = \frac{(\text{No-Load Hertz}) - (\text{Rated Capacity hertz})}{(\text{Service-Load hertz})} \times 100$$

4. Repeat steps 1 through 3 two additional times without making any adjustments.

- i. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

Ambient temperature (at 15 minute intervals).

Generator output current (before and after load changes).

Generator output voltage (before and after load changes).

Frequency (before and after load changes).

Generator output power (before and after load changes).

Graphic representations shall include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(1.) Perform and record engine manufacturer's recommended prestarting checks and inspections.

(2.) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(3.) With the unit at no load, apply the Maximum Step Load Increase.

(4.) Decrease load to zero percent in steps equal to the Maximum

Step Load Decrease.

- (5.) Repeat steps 3. through 5.
- j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. This test may be performed using any prime mover.
- (1.) Start and operate the generator set at rated voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.
  - (2.) Apply the specified load between terminals  $L_1-L_2$ ,  $L_2-L_0$ , and  $L_3-L_0$  in turn. Record all instrument readings at each line-neutral condition.
  - (3.) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.
  - (4.) Compare the largest differences expressed in percent with the maximum allowable difference specified.

### PART 3 EXECUTION

#### 3.1 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

#### 3.2 PIPING INSTALLATION

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with vibration-isolation-type flexible connectors. Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 1/2 inch drain valve with cap at each low point.

##### 3.2.1 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be

provided at pipe bends or change of direction.

#### 3.2.1.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods.

#### 3.2.1.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

#### 3.2.2 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

#### 3.2.3 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

#### 3.2.4 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

### 3.3 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 16415 ELECTRICAL WORK, INTERIOR.

#### 3.3.1 Vibration Isolation

Flexible fittings shall be provided for conduit, cable trays, and raceways attached to engine-generator sets. Metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor. Terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

### 3.4 FIELD PAINTING

Field painting shall be "Langley Brown" in accordance with Langley Air Force Base requirements.

### 3.5 ONSITE INSPECTION AND TESTS

#### 3.5.1 Test Conditions

##### 3.5.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations shall be in accordance with IEEE Std 1.

#### 3.5.1.2 Power Factor

For all engine-generator set operating tests the load power factor shall be the power factor specified in the engine-generator set parameter schedule .

#### 3.5.1.3 Contractor Supplied Items

The Contractor shall provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

#### 3.5.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5%, voltage plus or minus 1.5%, real power plus or minus 1.5%, reactive power plus or minus 1.5%, power factor plus or minus 3%, frequency plus or minus 0.5%. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

#### 3.5.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

#### 3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

##### 3.5.2.1 Piping Test

- a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing

fluid has no obvious sediment or emulsion.

- b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine-generator set shall be pressure tested with air pressure at 150% of the maximum anticipated working pressure, but not less than 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

#### 3.5.2.2 Electrical Equipment Tests

- a. Low-voltage cable insulation integrity tests shall be performed for cables connecting to the generator and associated equipment. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R$  in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)

$R$  in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

- c. Ground-Resistance Tests. The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the requirements resistance, but the specified number of electrodes must still be provided as follows:

(1.) Single rod electrode - 5 ohms.

(2.) Multiple rod electrodes - 1 ohms.

- d. Circuit breakers and switchgear shall be examined and tested in accordance with the manufacturer's published instructions for functional testing.

#### 3.5.3 Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall

be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1. Drive belts. (I)
2. Governor type and features. (I)
3. Engine timing mark. (I)
4. Starting motor. (I)
5. Starting aids. (I)
6. Coolant type and concentration. (D)
7. Radiator drains. (I)
8. Block coolant drains. (I)
9. Coolant fill level. (I)
10. Coolant line connections. (I)
11. Coolant hoses. (I)
12. Combustion air filter. (I)
13. Intake air silencer. (I)
14. Lube oil type. (D)
15. Lube oil sump drain. (I)
16. Lube-oil filter. (I)
17. Lube-oil level indicator. (I)
18. Lube-oil fill level. (I)
19. Lube-oil line connections. (I)
20. Lube-oil lines. (I)
21. Fuel type. (D)
22. Fuel-level. (I)
23. Fuel-line connections. (I)
24. Fuel lines. (I)
25. Fuel filter. (I)
26. Access for maintenance. (I)
27. Voltage regulator. (I)
28. Battery-charger connections. (I)
29. Wiring & terminations. (I)
30. Instrumentation. (I)
31. Hazards to personnel. (I)
32. Base. (I)
33. Nameplates. (I)
34. Paint. (I)
35. Exhaust-heat system. (I)
36. Exhaust muffler. (I)
39. Access provided to controls. (I)
40. Enclosure is weather resistant. (I)
41. Engine & generator mounting bolts (application). (I)

#### 3.5.4 Pre-operational Tests

##### 3.5.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms

initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.1.

#### 3.5.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested in accordance with IEEE Std 43. Stator readings shall be taken at the circuit breaker, to include generator leads to switchgear. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of switchgear assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

#### 3.5.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a total indicator reading of 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.002 inch will be acceptable.

#### 3.5.5 Safety Run Test

For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated safety tests shall be repeated.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- c. Activate the manual emergency stop switch and verify that the engine stops.
- d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.
- f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm

activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

- g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.
- i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- k. Operate the engine generator-set for at least 2 hours at 75% of Service Load.
- l. Verify proper operation and setpoints of gauges and instruments.
- m. Verify proper operation of ancillary equipment.
- n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.
- o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.
- p. Manually adjust the governor to increase engine speed to within 2% of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.
- q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.
- r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.
- s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold. The manifold shutoff valve shall be open and bleed valve closed.

- t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.
- u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.
- v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100% of Service Load. Record the maximum sound level in each frequency band at a distance of 35 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 35 feet from the engine at 45 degrees apart in all directions for vertical piping. If a sound limiting enclosure is provided, the enclosure, the muffler, and intake silencer shall be modified or replaced as required to meet the sound requirements contained within this specification
- w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.

### 3.5.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.

#### 3.5.6.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, with an average ambient temperature of 110 degrees F, during the month of August. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant.  
 Lube-oil.  
 Exhaust.  
 Ambient.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.
- c. Operate the engine generator-set for 2 hours at 75% of Service Load.
- d. Increase load to 100% of Service Load and operate the engine generator-set for 4 hours.
- e. For prime rated units, increase load to 110% of Service Load and operate the engine generator-set for 2 hours.
- f. Decrease load to 100% of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.
- g. Remove load from the engine-generator set.

3.5.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

- a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.
- b. Increase load to 100% of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.
- c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop \%} = \frac{\text{No-load volts} - \text{rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop \%} = \frac{\text{No load hertz} - \text{rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

- d. Repeat steps a. through c. two additional times without making any adjustments.

3.5.6.3 Voltage Regulator Range Test

- a. While operating at no load, verify that the voltage regulator

adjusts from 90% to 110% of rated voltage.

- b. Increase load to 100% of Rated Output Capacity. Verify that the voltage regulator adjusts from 90% to 110% of rated voltage.

#### 3.5.6.4 Governor Adjustment Range Test

- a. While operating at no load, verify that the governor adjusts from 90% to 110% of rated frequency.
- b. Increase load to 100% of Rated Output Capacity. Verify that the governor adjusts from 90% to 110% of rated frequency.

#### 3.5.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

- (1.) Ambient temperature (at 15 minute intervals).
- (2.) Generator output current (before and after load changes).
- (3.) Generator output voltage (before and after load changes).
- (4.) Frequency (before and after load changes).
- (5.) Generator output power (before and after load changes).
- (6.) Graphic representations shall include the actual instrument trace of voltage and frequency showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.
- c. With the unit at no load, apply the Maximum Step Load Increase.
- g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

- h. Repeat steps c. through g.

### 3.5.7 Parallel Operation Test

Test the capability of each engine-generator set to parallel and share load with other generator sets, individually and in all combinations. This test must be performed with the voltage regulator and governor adjustment settings used for the Frequency and Voltage Stability and Transient Response test. If settings are changed during the performance of this test, a voltage and frequency stability and transient response test must be performed for each engine generator set using the setting utilized in this test. During operations record load-sharing characteristics of each set in parallel operation. Data taken shall include the following:

- (1.) Ambient temperature (at 15 minute intervals).
- (2.) Generator output current (before and after load changes).
- (3.) Generator output voltage (before and after load changes).
- (4.) Power division and exchange between generator sets.
- (5.) Real power (watts) and reactive power (vars) on each set.

#### 3.5.7.1 Combinations

Connect each set, while operating at no load, parallel with one other set in the system, operating at service load, until all possible two-unit-in-parallel combinations have been achieved. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive loads. Document stabilization of voltage and frequency within specified bandwidth, the active power division, active power exchange, reactive power division, and voltage and frequency stability and transient response in the following steps for each combination.

- a. Divide the load proportionally between the sets and operate in parallel for 15 minutes.
- b. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to its service load.
- c. Decrease the load, in steps equal to the Maximum Step Decrease, until each set is loaded to approximately 25% of its service load.
- d. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to approximately 50% of its service load. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.
- e. Reduce the sum of the loads on both sets to the output rating of the smaller set.
- f. Transfer a load equal to the output rating of the smaller of the 2 sets to and from each set. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.
- g. Document the active power division, active power exchange, reactive

power division, and voltage and frequency stability and transient response .

### 3.5.7.2 Multiple Combinations

Connect each set, while operating at no load, parallel with all multiple combinations of all other set in the system, while operating at service load, until all multiple combinations of parallel operations have been achieved.

### 3.5.8 Automatic and Manual Operation Tests for Multiple Engine Generator Set Parallel Operation In Standalone Mode

The automatic operating system shall be tested to demonstrate automatic starting, loading and unloading, the response to loss of operating engine-generator sets, and paralleling of each engine-generator set. The loads for this test shall utilize load banks at the indicated power factor, and the loading sequence shall be the indicated sequence. During all operations load-sharing characteristics shall be recorded. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

- (1.) Ambient temperature (at 15 minute intervals).
  - (2.) Generator output current (before and after load changes).
  - (3.) Generator output voltage (before and after load changes).
  - (4.) Generator output frequency (before and after load changes).
  - (5.) Power division and exchange between generator sets.
  - (6.) Real and reactive power on each set.
- a. Initiate loss of the preferred power source and verify the specified sequence of operation.
  - b. Verify resetting of automatic starting and transfer logic.

### 3.5.9 Automatic and Manual Operation Tests for Stand-Alone Operation

The automatic and Manual loading system shall be tested to demonstrate automatic starting, and loading and unloading of each engine-generator set.

The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. Perform this test for a minimum of two successive, successful tests. Data taken shall include the following:

- (1.) Ambient temperature (at 15 minute intervals).
  - (2.) Generator output current (before and after load changes).
  - (3.) Generator output voltage (before and after load changes).
  - (4.) Generator output frequency (before and after load changes).
- a. Initiate loss of the primary power source and verify automatic sequence of operation.

- b. Restore the primary power source and verify sequence of operation.
- c. Verify resetting of controls to normal.

### 3.5.10 Fuel Consumption Tests

Fuel consumption tests to confirm the manufacturer's certified rates shall be performed on engine generator set and the results tabulated and averaged. Fuel consumption tests shall be conducted under the direct supervision of the engine manufacturer's representative. Fuel consumption readings shall be taken at 15 minute intervals, over a minimum period of 1 hour at 50% Service Load, 1 hour at 75% Service Load, and 4 hours at 100% Service Load. Fuel consumption data may be taken during the 75% load test and 100% load tests. Fuel consumption readings at site conditions shall be correlated to the guarantee-baseline conditions. Test report shall contain: readings of the output frequency, voltage, current, power factor, and power; barometric pressure; ambient temperature; intake-air temperature; fuel temperature; the site fuel consumption readings, adjustment calculations, factors, and source references for correlation of actual consumption rate of the guaranteed rate.

- a. Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency. During this period, readings of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the procurement document. Adjustments to the load, voltage or frequency controls shall be recorded on the data sheet. Unless otherwise specified in the procurement document, stabilization will be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.

- b. Perform one of the following procedures:

#### BALANCE SCALE PROCEDURE.

(1.) Supply fuel from auxiliary container mounted on a balance scale.

(2.) After stabilization has occurred, set the balance weights at any convenient value slightly less than the total weight of the fuel and container.

(3.) Start the stopwatch when the balance weights fall and record the total weight.

(4.) Reduce the balance weight a convenient amount and record the

amount of the weights removed.

(5.) Stop the stopwatch when the balance weights fall and record the total weight and the elapsed time.

(6.) Repeat steps (1) thru (2) above until the timed portion of the test exceeds the 2 hours.

(7.) From the total elapsed time and total of the weights removed calculate the fuel consumption in terms of pounds per hour.

(8.) Using the value obtained in step (7) above, compute the rate of fuel consumption per kilowatt hour, as follows:

$$\text{Pounds per kWh} = \frac{\text{Fuel Consumption in Pounds per Hour}}{\text{kW Load}}$$

(9.) Repeat the test for each load condition specified.

(10.) Determine the capacity of the generator set fuel tank in pounds of fuel.

(11.) For each specified load, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used.

$$\text{Operating hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per hour)}}$$

#### ALTERNATE PROCEDURE FOR WEIGHING FUEL

(1.) Supply fuel from the auxiliary fuel container, mounted on a platform balance, or other weighing device.

(2.) After stabilization has occurred, record weight readings every one-half hour for a period of 2 hours.

(3.) Calculate the average hourly fuel consumption rate in pounds per hour.

(4.) Using the average hourly fuel consumption rate obtained above, compute the rate of fuel consumption per kilowatt hour, as follows:

$$\text{Pounds per kWh} = \frac{\text{Fuel Consumption}}{\text{kW Load}}$$

(5.) Repeat test for each load condition specified.

(6.) Determine the capacity of the generator set fuel tank in pounds of fuel.

(7.) for each specified load test, compute the number of continuous ours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

## ALTERNATE PROCEDURE USING FLOWMETER.

Flowmeters may be used to determine the fuel rate. They usually are calibrated in either gallons per hour, or pounds per hour, for a fuel of a definite specific gravity and temperature.

- (1.) After stabilization has occurred record the fuel consumption rate, and continue to record the fuel consumption rate at one-half hour intervals for 2 hours.
- (2.) Determine the average of the readings (correct for fuel specific gravity and temperature). This is the fuel consumption rate and should be converted, if necessary, to pounds per hour.
- (3.) Using the average value obtained above, calculate the rate of fuel consumption per kilowatt hour.
- (4.) Repeat the test for each load condition specified.
- (5.) Determine the capacity of the generator set fuel tank in pounds of fuel.
- (6.) For each specified load test, compute the number of continuous hours the generator set will operate on a full tank of fuel. The following formula shall be used:

$$\text{Operating Hours} = \frac{\text{Fuel Tank Capacity (Pounds)}}{\text{Fuel Consumption (Pounds per Hour)}}$$

- c. Results. Compare the operating hours or the fuel consumption rate per kWh.

## 3.5.11 Final Testing and Inspection

- a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. Increase the load in steps no greater than the Maximum Step Load Increase to 100% of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.
- c. Remove load and shut down the engine-generator set after the recommended cool down period.
- d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.
- e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.
- f. Visually inspect and check engine and generator mounting bolts for

tightness and visible damage.

- g. Replace air, oil, and fuel filters with new filters.

### 3.6 POSTED DATA AND INSTRUCTIONS

Posted Data and Instructions shall be posted prior to field acceptance testing of the engine generator set. Two sets of instructions/data shall be typed and framed under weatherproof laminated plastic, and posted side-by-side where directed. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set of shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Two sets of instructions/data shall be typed in 8 1/2" x 11" format, laminated in weatherproof plastic, and placed in three-ring vinyl binders. The binders shall be placed as directed by the Contracting Officer. The instructions shall be in place prior to acceptance of the engine generator set installation. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).

### 3.7 ONSITE TRAINING

The Contractor shall conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. All operation and maintenance manuals shall be approved and made available for the training course. All posted instructions shall be approved and posted prior to the beginning date of the training course. The training course schedule shall be coordinated with the Using Service's work schedule, and submitted for approval 14 days prior to beginning date of proposed beginning date of training. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance procedures as described in the operation and maintenance manuals. Two copies of a video tape of the manufacturers operating and maintenance training course shall be submitted.

### 3.8 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --



## SECTION 16265

UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM, EACH SET  
09/98

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.110	(1998) Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 450	(1995) Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications
IEEE Std 485	(1997) Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA PE 1	(1992) Uninterruptible Power Systems
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

UPS System; G, AE.

Installation; G, AE.

Detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations per IEEE Std 485, installation instructions, single-line diagrams, ladder-type schematic diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as

a unit.

#### SD-03 Product Data

Performance Requirements; G, AE.

Pertinent performance data for the UPS system, using a copy of the data sheets supplied with this specification. Data sheets shall be certified by a responsible officer of the UPS manufacturer.

Spare Parts; G.

Spare parts data for each different item of material and equipment specified, not later than the date of beneficial occupancy. The data shall include a complete list of parts and supplies with current unit prices and source of supply and an itemized price breakdown of spare parts recommended for stocking. The recommended spare parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.

Field Training; G.

Lesson plans and training manuals for the training phases, including type of training to be provided and proposed dates, with a list of reference materials.

#### SD-06 Test Reports

Factory Testing; G, AE.

Field Supervision, Startup and Testing; G, AE.

A detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test, how it is to be performed, what it accomplishes, and its duration, not later than 2 months prior to the date of each test.

Factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. Factory and field test reports shall be signed by an official authorized to certify on behalf of the manufacturer of the UPS system that the system meets specified requirements. The reports shall be dated after the award of this contract, shall state the Contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

### 1.3 SYSTEM DESCRIPTION

The UPS system shall consist of UPS module, battery system, battery protective device, system cabinet (as required), bypass and transfer switching, maintenance bypass switch, controls and monitoring. Input ac power shall be connected to the normal source ac input of the UPS module. The battery shall be connected to the dc input of the UPS module through the battery protective device. The ac output of the UPS system shall be connected to the critical loads. The UPS system shall be a true online type system.

### 1.3.1 UPS Module and Battery System

UPS module shall contain required input isolation transformer, rectifier/charger unit, inverter unit and controls, battery protective device, and any other specified equipment/devices. Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required.

### 1.3.2 Cabinet, Bypass and Transfer Switching, Control and Monitoring

The UPS system shall include the system cabinet, static bypass transfer switch, system protective devices, monitoring and controls, means of isolating the system from the critical load, and remote monitoring interfaces.

#### 1.3.2.1 Maintenance Bypass

Provide a maintenance bypass complete. Static switching bypass is not acceptable for the maintenance bypass. The maintenance bypass switching shall be interlocked to prevent paralleling circuits. Circuit breakers shall be rated for the circuit voltage connected to and no less than 50,000 amperes interrupting capacity.

### 1.3.3 Design Requirements

#### 1.3.3.1 Parts and Materials

Parts and materials comprising the UPS system shall be new, of current manufacture, of a high grade and free of defects and imperfections, and shall not have been in prior service except as required during aging and factory testing.

#### 1.3.3.2 Components

Active electronic devices shall be solid state. Semiconductor devices shall be sealed. Relays shall be dust-tight.

#### 1.3.3.3 Semiconductor Fusing

Power semiconductors shall be fused to prevent cascaded or sequential semiconductor failures. Indicator lamp denoting blown fuse conditions shall be readily observable by the operator without removing panels or opening cabinet doors.

#### 1.3.3.4 Interchangeability

The subassemblies in one UPS module shall be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

#### 1.3.3.5 Control Power

Control power shall be derived from two sources, input and output, with automatic selective control. The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

#### 1.3.3.6 EMI/RFI Protection

The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

#### 1.3.3.7 Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of NFPA 70 and other applicable standards. Wire runs shall be protected in a manner which separates power and control wiring. Control wiring shall be minimum No. 16 AWG extra-flexible stranded copper. Logic-circuit wiring may be smaller. Ribbon cables shall be minimum No. 22 AWG. Control wiring shall have permanently attached wire numbers.

#### 1.3.3.8 Terminations

Terminals shall be supplied for making power and control connections. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type. Terminal blocks for field wiring shall be located in one place in each module and in the system cabinet. Control wiring shall be extended to the terminal block location. No more than two wires shall land on any terminal point. Where control wiring is attached to the same point as power wiring, a separate terminal shall be provided. If bus duct is used, bus stubs shall be provided where bus duct enters cabinets.

#### 1.3.3.9 Internal Assembly

The subassemblies shall be mounted in pull-out and/or swing-out trays where feasible. Cable connections to the trays shall be sufficiently long to allow easy access to all components. Where not feasible to mount subassemblies in pull-out or swing-out trays, they shall be firmly mounted inside the enclosure. Test points or logic indicators shall be labeled and located on the front edge of the control logic cards, if used.

#### 1.3.3.10 Cabinet Structure

UPS system shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. UPS module cabinet shall be structurally adequate for forklift handling or lifting. Removable lifting eyes shall be provided on top of each cabinet. UPS module cabinet shall have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Doors shall be key lockable. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the top or bottom of the cabinet.

#### 1.3.3.11 Cabinet Finish

Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards.

#### 1.3.3.12 Mimic Bus

Provide a mimic bus of the power system on the front of the cabinet. If painted, mimic bus and other front-panel markings (such as those showing circuit breakers or switches and fuses) shall be painted with durable acrylic-based paint.

#### 1.3.3.13 Live Parts (300 Volts and Above)

Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected or covered to minimize the chance of accidental contact.

#### 1.3.3.14 Drawout Assemblies

Drawout assemblies weighing 50 lbs or more shall be provided with a means of lifting, either an overhead device or a hoisting device.

#### 1.3.3.15 Safety

UPS shall be equipped with instruction plates including warnings and cautions, suitably located, describing any special or important procedures to be followed in operating and servicing the equipment.

### 1.3.4 Performance Requirements

#### 1.3.4.1 Normal Operation

The UPS module rectifier/charger shall convert the incoming ac input power to dc power for the inverter and for float charging the battery. The inverter shall supply ac power continuously. Inverter output shall be synchronized with the bypass ac power source, provided that the bypass ac power source is within the specified frequency range. The UPS system shall supply ac power to the critical loads.

#### 1.3.4.2 Loss of ac Input Power

The battery shall supply dc power to the inverter so that there is no interruption of ac power to the critical load whenever the ac input power source deviates from the specified tolerances or fails completely. The battery shall continue to supply power to the inverter for the specified protection time. At the same time, an alarm shall sound to alert operating personnel, allowing startup of a secondary power source or orderly shutdown of the critical load.

#### 1.3.4.3 Return of ac Input Power Source

The rectifier/charger shall start and assume the dc load from the battery when the ac input power source returns. The rectifier/charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.

#### 1.3.4.4 Failure of ac Input Power to Return

Should the ac input power fail to return before the battery voltage reaches the discharge limit, the UPS system shall disconnect from the critical load to safeguard the battery.

#### 1.3.4.5 Transfer to Bypass ac Power Source

When the static bypass switch senses an overload, two or more inverter shutdown signals, or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter output to the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules. If the bypass ac power source is out of normal tolerance limits, the UPS and

the critical load shall shut down.

#### 1.3.4.6 Retransfer to Inverter

The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions. Retransfer shall not occur if the two sources are not synchronized.

#### 1.3.4.7 UPS System Maintenance

Manual closure of the maintenance bypass switch shall transfer the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus. UPS module shall be capable of manual return to normal operation after completion of maintenance.

#### 1.3.4.8 Battery Maintenance

The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance. The UPS module shall continue to function and meet the performance criteria specified except for the battery function.

### 1.4 QUALITY ASSURANCE

#### 1.4.1 Reliability

UPS shall have a minimum acceptable system Mean Time Between Failures (MTBF) of 20,000 hours. A failure is defined as any interruption to or degradation of the UPS output. Automatic switching to bypass due to a problem with the UPS system does not constitute a failure, provided that the critical load is not disturbed.

#### 1.4.2 Maintainability

UPS shall have a maximum acceptable system Mean Time To Repair (MTTR) of 30 minutes. Repair time is defined as the clock time from the arrival of the service technician to the time when the UPS is restored to service either by repair or substitution of the failed component.

### 1.5 DELIVERY AND STORAGE

Equipment placed in storage shall be protected from humidity and temperature variations, dirt, dust, or other contaminants.

### 1.6 PROJECT/SITE CONDITIONS

#### 1.6.1 Environmental Conditions

The UPS and battery system shall be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.

- a. Operating altitude: Sea level to 4,000 feet. (Systems applied at higher altitudes shall be derated in accordance with the manufacturer's instructions).
- b. Non-operating altitude: Sea level to 40,000 ft.

- c. Operating ambient temperature range: 32 to 122 degrees F.
- d. Non-operating and storage ambient temperature range: Minus 4 to plus 140 degrees F.
- e. Operating relative humidity: 0 to 95 percent, without condensation.

#### 1.6.2 Sound Pressure Levels

Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of 5 feet in any direction from the perimeter of the unit, shall not exceed 65 dB as measured on the A scale of a standard sound level meter at slow response.

#### 1.6.3 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.7 NAME PLATES

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

#### 1.8 SPECIAL TOOLS

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

#### 1.9 OPERATION AND MAINTENANCE MANUALS

Six complete copies of operation manuals for the UPS System outlining the step-by-step procedures required for system startup, operation and shutdown shall be provided. The instructions shall include the manufacturer's name, equipment model number, service manual, parts list, and brief description of equipment and its basic operational features. Six complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment. Operation and maintenance manuals may be either combined or separate.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

#### 2.2 LOAD PROFILE

The UPS system shall be compatible with the load characteristics defined in

the LOAD PROFILE TABLE below and load configuration shown. Compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush shall be provided.

#### LOAD PROFILE TABLE

Type of load: Electronic Data Processing Equipment.

Size of load: As Indicated.

Switching pattern: Unswitched.

Steady-state characteristics: As Indicated.

Special factors: The UPS System shall be capable of supplying rated output within specified limits with harmonic loads with a K Factor rating of K13.

### 2.3 UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load at .9 power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

#### 2.3.1 System Capacity

Provide KVA rating as indicated at .95 power factor.

#### 2.3.2 Module Capacity

Provide KVA rating as indicated at .95 power factor.

#### 2.3.3 Battery Capacity

Discharge time to end voltage: 15 minutes, at 77 degrees F. Battery shall be capable of delivering 125 percent of full rated UPS load at initial start-up.

#### 2.3.4 Static Switch

Provide mperes symmetrical interrupting capacity same as the upstream circuit protective device (circuit breaker).

#### 2.3.5 System Bus Bracing

Braced for amperes symmetrical interrupting capacity same as the upstream circuit protective device (circuit breaker) interrupting capacity.

#### 2.3.6 ac Input

- a. Voltage 480 volts line-to-line.
- b. Number of phases: 3-phase, 3-wire, plus ground.
- c. Voltage Range: Plus 10 percent, minus 15 percent, without affecting battery float voltage or output voltage.
- d. Frequency: 60 Hz, plus or minus 5 percent.
- e. Power walk-in: 20 percent to 100 percent over 15 to 24 seconds.

- f. Total harmonic current distortion (THD) reflected into the primary line: 10 percent maximum.
- g. Transformer sub-cycle inrush: 4 to 8 times full load rating.

#### 2.3.7 ac Output

- a. Voltage 480 volts line-to-line, 277 volts line-to-neutral.
- b. Number of phases: 3-phase, 4-wire, plus ground.
- c. Voltage regulation:
  - (1) Balanced load: Plus or minus 1.0 percent.
  - (2) 50 percent load imbalance, phase-to-phase: Plus or minus 2 percent.
  - (3) No-load voltage modulation: Plus or minus 1 percent.
  - (4) Voltage drift: Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions.
- d. Voltage adjustment: Plus or minus 5 percent manually.
- e. Frequency: 60 Hz.
- f. Frequency regulation: Plus or minus 0.1 percent.
- g. Frequency drift: Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.
- h. Harmonic content (RMS voltage): 3 percent single harmonic, maximum; 5 percent total maximum with linear load. Voltage THD shall be less than 7 percent with up to 50 percent nonlinear load and a crest factor of less than 3 to 1.
- i. Load power factor operating range: 1.0 to 0.8 lagging.
- j. Phase displacement:
  - (1) Balanced load: Plus or minus 1 degree of bypass input.
  - (2) 50 percent load imbalance phase-to-phase: Plus or minus 3 degrees of bypass input.
- k. Wave-form deviation factor: 5 percent at no load.
- l. Overload capability (at full voltage) (excluding battery):
  - (1) 125 percent load for 10 minutes.
  - (2) 150 percent load for 30 seconds.
  - (3) 300 percent load for one cycle after which it shall be current limited to 150 percent until fault is cleared or UPS goes to bypass.

- m. Load sharing of parallel modules: Plus or minus 5 percent of average load per module.

#### 2.3.8 Transient Response

##### 2.3.8.1 Voltage Transients

- a. 50 percent load step/0 percent to 50 percent load: Plus or minus 8 percent.
- b. 50 percent load step/50 percent to 100 percent load: Plus or minus 8 percent.
- c. Loss or return of ac input: Plus or minus 1 percent.
- e. Automatic transfer of load from UPS to bypass: Plus or minus 4 percent.
- f. Manual retransfer of load from bypass to UPS: Plus or minus 4 percent.
- g. Response time: Recovery to 99 percent steady-state condition within 50 milliseconds after any of the above transients.

##### 2.3.8.2 Frequency

- a. Transients: Plus or minus 0.5 Hz maximum.
- b. Slew Rate: 1.0 Hz maximum per second.

#### 2.3.9 Efficiency

- a. Minimum Single-Module Efficiency: 90 percent at full load kW.
- b. Minimum System Efficiency: 89 percent at full system load kW.

### 2.4 UPS MODULE

#### 2.4.1 General Description

UPS module shall consist of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices and accessories as required for operation.

#### 2.4.2 Rectifier/Charger Unit

Rectifier/charger unit shall be solid state and shall provide direct current to the dc bus.

##### 2.4.2.1 Input Protective Device

Rectifier/charger unit shall be provided with an input protective device. The protective device shall be sized to accept simultaneously the full-rated load and the battery recharge current. The protective device shall be capable of shunt tripping and shall have amperes symmetrical interrupting capacity as indicated. The protective device shall have provision for locking in the "off" position. A surge suppression device

shall be installed at the UPS input to protect against lightning and switching surges.

#### 2.4.2.2 Power Transformer

A dry-type, isolated-winding power transformer shall be used for the rectifier unit. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation material when operating at full load. The transformer insulation shall be Class H, 150 degrees C rise. Transformer connections shall be accessible from the front.

#### 2.4.2.3 Power Walk-In

Rectifier/charger unit shall be protected by a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current. This demand shall increase gradually to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

#### 2.4.2.4 Sizing

Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:

- a. Supplying the full rated load current to the inverter.
- b. Recharging a fully-discharged battery to 95 percent of rated ampere-hour capacity within ten times the discharge time after normal ac power is restored, with the input protective device closed.

#### 2.4.2.5 Battery Charging Current

- a. Primary current limiting: Battery-charging current shall be voltage regulated and current limited. The battery-charging current limit shall be separately adjustable from 2 percent to 25 percent of the maximum discharge current. After the battery is recharged, the rectifier/charger unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.
- b. Second step current limiting: The rectifier/charger unit shall also have a second-step battery current limit. This second-step current limit shall sense actual battery current and reduce the input power demand for battery recharging to 50 percent (adjustable from 30 percent to 70 percent) of the normal rate without affecting the system's ability to supply full-rated power to the connected load. The second-step current-limit circuit shall be activated by a dry contact signal from the generator set controls and shall prevent normal rate battery recharging until utility power is restored.

#### 2.4.2.6 Output Filter

Rectifier/charger unit shall have an output filter to minimize ripple current supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS.

#### 2.4.2.7 dc Voltage Adjustment

Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.

#### 2.4.2.8 Battery Isolation Protective Device

Module shall have a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating shall be as required by system capacity and shall incorporate a shunt trip as required by circuit design. The protective device shall have provision for locking in the "off" position.

#### 2.4.3 Inverter Unit

Inverter unit shall be a solid-state device capable of accepting power from the dc bus and providing ac power within specified limits.

##### 2.4.3.1 Output Overload

The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall continue to operate within rated parameters, with inverse-time overload shutdown protection.

##### 2.4.3.2 Synchronism

The inverter shall normally operate in phase-lock and synchronism with the bypass source. Should the bypass source frequency deviate beyond 60 Hz by more than 0.5 Hz, the internal frequency oscillators contained in the power module shall be used to derive the new frequency reference. Upon restoration of the bypass source within the required tolerance, the inverter shall resynchronize with that source at a slew rate not exceeding the specified rate. The oscillator shall be temperature compensated and shall be manually adjustable. The design of the oscillator and synchronizing circuits shall be such that failure of any associated component, connector pin, terminal lead wire or dc power source in either the open or shorted mode shall affect only one inverter leg. Such failure shall not cause transient disturbance of the critical load in excess of the stated limits.

##### 2.4.3.3 Phase Balance

Electronic controls shall be incorporated to provide individual phase voltage compensation to obtain phase balance.

##### 2.4.3.4 Modular Construction

Each control logic printed circuit board shall be electrically and physically packaged on an individual plug-in module with separate indication and adjustments.

##### 2.4.3.5 Output Protective Device

The output protective device shall be capable of shunt tripping and shall have interrupting capacity as specified. Protective device shall have provision for locking in the "off" position.

#### 2.4.3.6 Output Transformer

The inverter output transformer shall be similar to the input transformer and shall be capable of handling up to K-13 nonlinear loads as described in IEEE C57.110.

#### 2.4.4 External Protection

UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. The UPS system shall sustain input surges without damage in accordance with IEEE C62.41. The UPS shall also have built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.

#### 2.4.5 Internal Protection

UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. UPS module shall be provided with output reverse power detection which shall cause that module to be disconnected from the critical load bus when output reverse power is present. UPS module shall have built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shall shut down without damage to internal components.

### 2.5 STATIC BYPASS TRANSFER SWITCH

A static bypass transfer switch shall be provided as an integral part of the UPS and shall consist of a static switch and a bypass protective device or bypass switch. The control logic shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer switch shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer switch shall be used to connect the bypass ac power source or the UPS inverter output to the critical load when required, and shall have the following features:

#### 2.5.1 Uninterrupted Transfer

The static bypass transfer switch shall automatically cause the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:

- a. Inverter overload exceeds unit's rating.
- b. Battery protection period is expired and bypass is available.
- c. Inverter failure.

#### 2.5.2 Interrupted Transfer

If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output shall current-limit for 200 milliseconds minimum. The inverter shall then turn off and an interrupted transfer to the bypass ac power source shall be made. If the bypass ac power source is beyond the conditions stated below, an interrupted transfer shall be made upon detection of a fault condition:

- a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.
- b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.
- c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.

### 2.5.3 Manual Transfer

It shall be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off.

### 2.5.4 Automatic Uninterrupted Forward Transfer

The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned "on", or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit's 100 percent rating.

### 2.5.5 Forced Transfer

The control logic circuitry shall provide the means of making a forced or reverse transfer of the static bypass transfer switch on an interrupted basis. Minimum interruption shall be 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.

### 2.5.6 Overload Ratings

The static bypass transfer switch shall withstand the following overload conditions:

- a. 2000 percent of UPS output rating for two cycles.
- b. 200 percent of UPS output rating for 5 minutes.
- c. 125 percent of UPS output rating for 10 minutes.

### 2.5.7 Static Switch Disconnect

A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The switch shall be equipped with auxiliary contacts and provision for padlocking in either the "on" or "off" position.

## 2.6 MAINTENANCE BYPASS SWITCH

### 2.6.1 General

A maintenance bypass switch shall be provided as an integral part of the UPS and located within the UPS module. The maintenance bypass switch shall

provide the capability to continuously support the critical load from the bypass ac power source while the UPS is isolated for maintenance. The maintenance bypass switch shall be housed in an isolated compartment inside the UPS cabinet in such a way that service personnel will not be exposed to electrically live parts while maintaining the unit. Switch shall contain a maintenance bypass protective device and a module isolation protective device.

#### 2.6.2 Load Transfer

The maintenance bypass switch shall provide the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.

#### 2.6.3 Load Bank Protective Device

A load bank protective device shall be provided to allow the UPS system to be tested using a portable load bank. The load bank protective device shall be connected on the line side of the maintenance bypass switch isolation protective device.

### 2.7 MODULE CONTROL PANEL

The UPS module shall be provided with a control/indicator panel. The panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel.

#### 2.7.1 Module Meters

##### 2.7.1.1 Monitored Functions

The following functions shall be monitored and displayed:

- a. Input voltage, phase-to-phase (all three phases).
- b. Input current, all three phases.
- c. Input frequency.
- d. Battery voltage.
- e. Battery current (charge/discharge).
- f. Output voltage, phase-to-phase and phase-to-neutral (all three phases).
- g. Output current, all three phases.
- h. Output frequency.
- i. Output kilowatts.
- j. Elapsed time meter to indicate hours of operation, 6 digits.
- k. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).
- l. Output kilovars.

- m. Output kilowatt hours, with 15-minute demand attachment.

#### 2.7.1.2 Meter Construction

Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits).

#### 2.7.2 Module Controls

Module shall have the following controls:

- a. Lamp test/reset pushbutton.
- b. Alarm test/reset pushbutton.
- c. Module input protective device trip pushbutton, with guard.
- d. Module output protective device trip pushbutton, with guard.
- e. Battery protective device trip pushbutton, with guard.
- f. Emergency off pushbutton, with guard.
- g. dc voltage adjustment potentiometer, with locking guard.
- h. Control power off switch.
- i. UPS/bypass transfer selector switch.
- j. Static bypass transfer switch enable/disable selector switch.

#### 2.7.3 Module Alarm Indicators

Module shall have indicators for the following alarm items. Any one of these conditions shall turn on an audible alarm and the appropriate summary indicator. Each new alarm shall register without affecting any previous alarm.

- a. Input ac power source failure.
- b. Input protective device open.
- c. Output protective device open.
- d. Overload.
- e. Overload shutdown.
- f. dc overvoltage.
- g. dc ground fault.
- h. Low battery.
- i. Battery discharged.
- j. Battery protective device open.

- k. Blower failure.
- l. Input transformer overtemperature.
- m. Inverter transformer overtemperature.
- n. Equipment overtemperature.
- o. Operating on internal oscillator.
- p. Fuse blown.
- q. Control power failure.
- r. Charger off.
- s. Inverter off.
- t. Emergency off.
- u. UPS on battery.
- v. Critical load on static bypass.
- w. Static bypass transfer switch disabled.
- x. Inverter output overvoltage.
- y. Inverter output undervoltage.
- z. Inverter output overfrequency.
- aa. Inverter output underfrequency.
- bb. Bypass source overvoltage.
- cc. Bypass source undervoltage.
- dd. Bypass source overfrequency.
- ee. Bypass source underfrequency.
- ff. Bypass source to inverter out of synchronization.

#### 2.7.4 Module Mimic Panel

UPS module shall have a mimic panel in the format of a module single-line diagram, with status indicators for input, output, battery protective devices, and battery disconnect switch. Each protective device shall have indicators for open (green) and closed (red), to give positive indication. The mimic panel shall provide indication of the following additional functions:

- a. Charger on (functional).
- b. UPS on-line (inverter furnishing load power).
- c. UPS on-bypass (static switch operating).

- d. System alarm (flashes for abnormalities, minor or major faults).

#### 2.7.5 Module Emergency Off Button

Pressing the emergency off button shall cause the affected module to be disconnected from the system, via its input protective device, output protective device, and battery protective device. Activation of this button shall not affect the operation of the remainder of the system.

#### 2.8 SELF-DIAGNOSTIC CIRCUITS

The control logic shall include status indicators for trouble-shooting the control circuits. These indicators shall be mounted on the circuit card edge or face such that they will be visible without repositioning the card, and shall be labeled with the function name.

#### 2.9 REMOTE MONITORING PANEL

A remote monitoring panel shall be provided to monitor system status. The panel shall be designed for wall mounting near the critical load.

##### 2.9.1 Indicators

Minimum display shall include the following indicators:

- a. Load on UPS.
- b. Load on battery.
- c. Load on bypass.
- d. Low battery.
- e. Summary alarm.
- f. New alarm (to alert the operator that a second summary alarm condition has occurred).

##### 2.9.2 Audible Alarm

Any single indicator shall also turn on the audible alarm. An audible alarm test/reset button and lamp test/reset button shall be included. This reset button shall not affect nor reset the alarm on the module or on the system cabinet.

#### 2.10 COMMUNICATIONS AND DATA ACQUISITION PORT

An RS 232C and RS 485 communications and data acquisition port shall be provided. This port shall allow the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

#### 2.11 TEMPERATURE CONTROL

##### 2.11.1 General

Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. The cooling fans shall

continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel. Air inlets shall have filters that can be replaced without opening the cabinet doors.

#### 2.11.2 Blower Power Source

Blower power source shall be internally derived from the input and output sides of UPS module, with automatic transfer arrangement.

#### 2.11.3 Temperature Sensors

Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall monitor the temperature of rectifier and inverter heat sinks. Separate sensors shall also monitor the transformer temperature. Critical equipment overtemperature indication shall start a timer that shall shut down the UPS system if the temperature does not return below the setpoint level in 15 minutes.

### 2.12 BATTERY SYSTEM

#### 2.12.1 General

A storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration shall be provided for each UPS module. The battery shall be of heavy-duty, industrial design suitable for UPS service. The cells shall be provided with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.

#### 2.12.2 Battery Ratings

- a. Type: nickel cadmium.
- b. Specific gravity when fully charged: 1.215.
- c. End voltage 1.67 volts per cell.
- d. Float voltage: 2.17 to 2.26 volts per cell.
- e. Equalizing voltage: 2.33 to 2.38 volts per cell.

#### 2.12.3 Battery Construction

The battery shall be of the valve-regulated, sealed, non-gassing, recombinant type.

#### 2.12.4 Battery Cabinet

The battery pack assembly shall be furnished in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. External wiring interface

shall be through the bottom or top of the assembly. A smoke and high temperature alarm shall annunciate detection of either smoke or high temperature within the battery cabinet.

#### 2.12.5 Cell-Terminal Covers

Acid-resistant transparent cell-terminal covers not exceeding 6 feet in length and with vent holes drilled on top where needed shall be provided.

#### 2.12.6 Battery Disconnect

Each battery pack assembly shall have a fused disconnect switch or circuit breaker provided in a NEMA 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Switch/circuit breaker shall be complete with line side and load side bus bars for connection to battery cells. Switch shall be rated 480 V dc, amperes as required, 3-pole with interrupting rating as required by system capacity, and shall have an external operator that is lockable in the "off" position.

#### 2.12.7 Seismic Requirements

The battery support system shall SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

#### 2.12.8 Battery Monitor

A battery monitor shall be provided for each battery pack assembly. At a minimum, this device shall monitor the following parameters:

- a. Total system voltage.
- b. Ambient room temperature.
- c. Total battery discharge cycles with a duration of greater than 30 seconds but less than 5 minutes .

The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

### 2.13 FACTORY TESTING

The UPS system shall be factory tested to meet the requirements specified using a test battery (not the battery to be supplied with the system). UPS module shall be factory load tested as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes. Load shall be balanced at rated kVA and rated power factor. Factory tests for the UPS module shall be run under full load, and will be witnessed by the Government. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings. The Government shall be notified in writing at least 2 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Government that the system is ready for testing. Factory tests shall be performed during normal business hours. The system shall be interconnected and tested for an additional 8 hours to ensure proper wiring and performance.

### 2.13.1 Transient Tests

Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Government. These tests shall include 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. A recording instrument equipped with an event marker shall be used.

### 2.13.2 Efficiency Tests

Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps, 0.8 power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with modules connected to the system to represent actual operating conditions.

## 2.14 INSPECTION

Inspection before shipment is required. The manufacturer shall notify the Government at least 2 weeks before shipping date so that an inspection can be made.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The UPS system shall be set in place, wired and connected in accordance with the approved shop drawings and manufacturer's instructions. The UPS battery shall be shipped to the site dry. Provide weight spreading plates that will support the UPS system for transporting the UPS system over raised access flooring specified to the UPS system installation locations. The weight spreading plates shall be sufficient to support the UPS system and not deform or cause to fail, the raised access flooring system when the UPS system is transported over the raise access flooring.

### 3.2 FIELD SUPERVISION, STARTUP AND TESTING

The services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment and testing of the equipment. The representative shall check the wiring between equipment, start up the system, and field test the functions, interlocks and protective devices to ensure that the total system is functioning according to the intent of the design. The field tests shall be performed under the supervision of a factory-trained representative of the equipment manufacturer and witnessed by the Government. The Government shall be given 2 weeks written advance notice of the date and time when testing will be conducted.

#### 3.2.1 Field Tests

As a minimum, the startup and field test procedures shall include the following:

- a. Ensure that shipping members have been removed.
- b. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc).

- c. Ensure that interiors are free of foreign materials, tools and dirt.
- d. Attach a phase rotation meter to the UPS input, output and bypass buses, and observe proper phase sequences.
- e. Torque test bus connections at shipping splits. Also torque test battery connections.
- f. Check each electrical bus for proper phasing and identification.
- g. Check and test selector switches and meters for proper operation.
- h. Check doors for proper alignment and operation.
- i. Check and test each protective device for proper mechanical and electrical operation.
- j. Check protective device overcurrent trip settings.
- k. Check and test indicating lights for proper operation and color.
- l. Perform onsite field test procedures.
- m. Demonstrate to the Government that the specified functions and interlocks have been implemented.
- n. Provide IEEE Std 450 battery installation certification.
- o. Check key interlock key numbers, if used, to ensure agreement with interlocking scheme.

### 3.2.2 Load Test

The installed system shall be load tested for a continuous 24 hour period by means of resistive load banks. The system shall be continuously tested at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. The equipment manufacturer shall provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above. Instrument readings shall be recorded every half hour for the following:

- a. Input voltage (all three phases, for each module).
- b. Input current (all three phases, for each module).
- c. Input frequency.
- d. Battery voltage for each module.
- e. Output voltage (all three phases, for each module).
- f. Output current (all three phases, for each module).
- g. Output kilowatts for each module.
- h. Output frequency.
- i. Output voltage (all three phases - system output).

- j. Output current (all three phases - system output).
- k. Output kilowatts (system output).

### 3.2.3 Full Load Burn In Test

The installed system shall undergo an additional full load burn-in period of 24 continuous hours. If a failure occurs during the burn-in period, the tests shall be repeated. Instrument readings shall be recorded every half hour as above. During the burn-in period, the following tests shall be performed:

- a. With the UPS carrying maximum continuous design load and supplied from the normal source, switch 100 percent load .
- b. With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations described in step a. Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.
- c. With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step a above.
- d. Continue operation on battery power for 1 minute, then restore normal power.

The Contractor shall furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Four copies of the traces shall be delivered to the Contracting Officer.

### 3.2.4 Battery Discharge Test

With the battery fully charged, the system shall undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Instrument readings shall be recorded every minute during discharge for the following:

- a. Battery voltage for each module.
- b. Battery current for each module.
- c. Output voltage (all three phases) for each module.
- d. Output current (all three phases) for each module.
- e. Output kilowatts for each module.
- f. Output voltage (all three phases - system output).
- g. Output current (all three phases - system output).
- h. Output kilowatts (system output).
- i. Output frequency.

### 3.3 POSTING FRAMED DATA AND INSTRUCTIONS

Framed data and instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

### 3.4 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 12 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Field training shall cover the items contained in the operating and maintenance manuals. The 12 hours shall be divided into two sessions of 6 hours each. Each session shall be conducted on a different day. A factory training videotape shall be provided as part of the training materials.

UPS SYSTEM PERFORMANCE DATA SHEET

SHEET 1 OF 6

ITEM	SPECIFIED	SUBMITTED
SYSTEM OPERATION	[ SINGLE MODULE ] [ PARALLEL REDUNDANT ] [ PARALLEL NON REDUNDANT ]	
NUMBER OF SYSTEMS	[ _____ ]	
GENERAL	NUMBER OF MODULES PRESENT [ _____ ]	
	IN EACH SYSTEM FUTURE [ _____ ]	
RATED	SYSTEM CAPACITY:	
	PRESENT [ _____ ] kW/[ _____ ] kVA FUTURE [ _____ ] kW/[ _____ ] kVA	
LOAD	BATTERY ONE PER MODULE	
	MTBF (SYSTEM)	
	MTTR	
	MODULE RATING [ _____ ] kW/[ _____ ] kVA	
MODUL	DC VOLTAGE WINDOW [ _____ ] Vdc	
	INPUT/OUTPUT	
LOAD	PROTECTIVE DEVICE [ _____ ] A SYM.	
	INTERRUPT. RATING	
	MANUFACTURER _____	
BATTERY	TYPE [ LEAD-CALCIUM ] [ LEAD-ANTIMONY ] [ NICKEL-CADMIUM ]	
	DISCHARGE TIME TO	
TEST	END VOLTAGE AT [ _____ ] MINUTES	
	FULL LOAD	
REPLY	END VOLTAGE [ _____ ] V/CELL	
	SPECIFIC GRAVITY [ _____ ]	
	FLOAT VOLTAGE [ _____ ] V/CELL	
	NUMBER OF CELLS [ _____ ] CELLS	

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 2 OF 6

ITEM	SPECIFIED	SUBMITTED
B A T T	HYDROGEN GENERATION _____ RECHARGE TIME TO 95% CAPACITY	10 X DISCHARGE
S C Y A S B T I E N M E T	PROTECTIVE DEVICE [AIR POWER, DRAW-OUT] [_____] _____ MANUFACTURER _____ INTERRUPTING RATE [_____] A SYM. STATIC SWITCH [_____] A	
	VOLTS, LINE/LINE [_____] V	
	PHASES [3-PHASE, 3-WIRE] [_____] _____	
A C I N P U T	VOLTAGE RANGE + 10%, - 15% FREQUENCY [50] [60] Hz FREQUENCY RANGE +/- 5% POWER WALK-IN 20% TO 100% LOAD	15 - 24 SECONDS
	TOTAL HARMONIC DISTORTION [5% MAX (CURRENT)] [_____] _____ REFLECTED-PRIMARY	
	ORDER OF HARMONIC _____ PERCENTAGE OF TOTAL	
	2nd _____	
	3rd _____	
	4th _____	
	5th _____	
	6th _____	
	7th _____	
	8th _____	
	9th _____	
(FILL IN AS REQUIRED)	TRANSFORMER SUB- CYCLE INRUSH [_____] x FULL LOAD	
	POWER FACTOR [0.8] [0.9]	

UPS SYSTEM PERFORMANCE DATA SHEET

SHEET 3 OF 6

ITEM	SPECIFIED	SUBMITTED
VOLTAGE, LINE-LINE	[ _____ ] V	
PHASES	3-PHASE, 4-WIRE	
POWER FACTOR	0.8 LAGGING, 1.0	
VOLTAGE REGULATION		
BALANCED LOAD	+/- 1.0%	
50% IMBALANCE BETWEEN PHASES	+/- 2.0%	
NO-LOAD MODULATION	+/- 1.0%	
DRIFT (30 DAYS)	+/- 1.0%	
VOLTAGE ADJUST.	+/- 5.0% MANUALLY	
A C  O U T P U T	FREQUENCY	60 Hz
	REGULATION	+/- 0.1%
	DRIFT (24 HRS.)	+/- 0.1%
HARMONIC CONTENT		
	TOTAL (50% NON-LINEAR LOAD)	7.0% MAX.
	TOTAL (LINEAR LOAD)	5.0% MAX.
	SINGLE HARMONIC (LINEAR LOAD)	3.0% MAX.
PHASE DISPLACEMENT		
	BALANCED LOAD	+/- 1.0 DEG. OF BYPASS
	50% IMBALANCE	+/- 3.0 DEG. OF BYPASS
WAVE FORM		
	DEVIATION FACTOR (NO LOAD)	5.0%
OVERLOAD CAPACITY		
	125%	10 MINUTES
	150%	30 SECONDS
	300%	MOMENTARY

UPS SYSTEM PERFORMANCE DATA SHEET

SHEET 4 OF 6

ITEM	SPECIFIED	SUBMITTED
LOAD SHARING AMONG MODULES	+/- 5.0% OF AVERAGE LOAD	
VOLT. TRANSIENT RESPONSE		
50% STEP LOAD 0% to 50%	+/- 8.0%	
50% STEP LOAD 50% to 100%	+/- 8.0%	
LOSS OR RETURN OF INPUT	+/- 1.0%	
LOSS OR RETURN OF A REDUNDANT MODULE		
AUTOMATICALLY	+/- 8.0%	
MANUALLY	+/- 8.0%	
A C  O U T P U T AUTO TRANSFER, AT FULL LOAD, FROM UPS TO BYPASS	+/- 4.0%	
MANUAL TRANS- FER, AT FULL LOAD, FROM BYPASS TO UPS	+/- 4.0%	
RECOVERY TIME TO 99% STEADY- STATE COND.	50 MILLISECONDS	
FREQUENCY TRANS- IENT RESPONSE	+/- 0.5 Hz	
SLEW RATE	1.0 Hz/SECOND	

UPS SYSTEM PERFORMANCE DATA SHEET

SHEET 5 OF 6

ITEM	SPECIFIED	SUBMITTED
A C U T P U T	EFFICIENCY @ FULL LOAD MODULE	[_____]%
	SYSTEM	[_____]%
	SYSTEM NOISE GEN. LEVEL @ 6 FT. FROM EQUIPMENT	[_____] DBA
	OPERATING AMBIENT TEMPERATURE	32 to [104] [122] DEG. F
	STORAGE AMBIENT TEMPERATURE	-4 to +140 DEG. F.
E N V I R O N M E N T	BATTERY ROOM AMBIENT TEMP.	77 DEG. F NOMINAL
	RELATIVE HUMIDITY (NON-CONDENSING)	0 - 95%
	BAROMETRIC PRES- SURE (ALTITUDE)	
	OPERATING	0 - [_____] FT.
	NON-OPERATING	0 - 40,000 FT.
	HEAT REJECTION	_____
	MODULE	
	SYSTEM	
P H Y S I C A L	MODULE	_____
	SIZE	
	WEIGHT	
	SYSTEM CABINET	_____
D A T A	SIZE	
	WEIGHT	



UPS SYSTEM PERFORMANCE DATA SHEET

SHEET 6 OF 6

ITEM	SPECIFIED	SUBMITTED
P D H A Y T BATTERY S A	_____	
I SEISMIC PARAMETERS		
C RACKS SIZE		
A WEIGHT		
L CELLS SIZE		
	WEIGHT	
	DISCON- SIZE	
	NECT WEIGHT	

-- End of Section --

## SECTION 16370

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL  
07/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	(1986; R 1995) Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(1989; R 1995) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(1984; R 1995) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1996) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI C29.8	(1985; R 1995) Wet-Process Porcelain Insulators - Apparatus, Cap and Pin Type
ANSI C29.9	(1983; R 1996) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.2	(1999) Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
ANSI C135.4	(1987) Zinc-Coated Ferrous Eyebolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C135.22	(1988) Zinc-Coated Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2001a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2001a) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 475 (1998) Zinc-Coated Steel Wire Strand

ASTM A 575 (1996; R 2002) Steel Bars, Carbon, Merchant Quality, M-Grades

ASTM A 576 (1990b; R 2000) Steel Bars, Carbon, Hot-Wrought, Special Quality

ASTM B 1 (2001) Hard-Drawn Copper Wire

ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM D 1654 (1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C4 (1999) Poles - Preservative Treatment by Pressure Processes

AWPA C25 (2001) Sawn Crossarms - Preservative Treatment by Pressure Processes

AWPA P5 (2001) Standard for Waterborne Preservatives

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2002) National Electrical Safety Code

IEEE C57.19.00 (1991; R 1997) Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings

IEEE C57.19.01 (2000) Performance Characteristics and Dimensions for Outdoor Apparatus Bushings

IEEE C62.1 (1989; R 1994) Surge Arresters for AC Power Circuits

IEEE C62.11 (1999) Metal-Oxide Surge Arresters for AC Power Circuits

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

IEEE Std 100 (2000) IEEE Standard Dictionary of

## Electrical and Electronics Terms

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA HV 2	(1984; R 1996) Application Guide for Ceramic Suspension Insulators
NEMA LA 1	(1992; R 1999) Surge Arresters
NEMA SG 2	(1993) High Voltage Fuses

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
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## U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS REA Bull 1728H-701	(1993) REA Specification for Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys
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## UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; Rev thru Feb 2001) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru May 2001) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev thru May 2001) Wire Connectors for Use with Aluminum Conductors

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

## 1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall conform to Section 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT .

- a. Altitude 50 Feet
- b. Ambient Temperature 40 degrees Celsius
- c. Frequency 60 hertz
- d. Corrosive Areas Salt Environment

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrical Distribution System; G, AE.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

- a. Poles.
- b. Calculations for power installed screw foundations.
- c. Crossarms.
- d. Conductors.
- e. Insulators.
- f. Surge arresters.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

- a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.

- b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

As-Built Drawings; G.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings

shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

Nameplates; G, AE.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G, AE.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

General Installation Requirements; G, AE.

As a minimum, installation procedures for regulators, transformers and reclosers. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

#### SD-06 Test Reports

Factory Tests; G, AE.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

Field Testing; G.

A proposed field test plan 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

## Operating Tests; G.

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings, and including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

## SD-07 Certificates

## Material and Equipment; G.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies.

## SD-10 Operation and Maintenance Data

## Electrical Distribution System; G.

Six copies of Operation and Maintenance manuals electrical distribution system shall be provided, within 7 calendar days following the completion of tests and shall include assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for

system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare-parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

Three additional copies of the instructions manual within 30 calendar days following the approval of the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### PART 2 PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.3 NAMEPLATES

##### 2.3.1 General

Each major component shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid-dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal. As a minimum, nameplates shall be provided for transformers, regulators, circuit breakers, capacitors, meters and switches.

## 2.4 CORROSION PROTECTION

### 2.4.1 Aluminum Materials

Aluminum shall not be used.

### 2.4.2 Ferrous Metal Materials

#### 2.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.4.2.2 Equipment

Equipment and component items, including but not limited to transformers and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.4.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTS AND COATINGS.

## 2.5 CONDUCTORS, CONNECTORS, AND SPLICES

### 2.5.1 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

### 2.5.2 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum-composition to copper shall comply with UL 486B, and copper-to-copper shall comply with UL 486A.

## 2.6 MEDIUM-VOLTAGE LINES

### 2.6.1 Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall be hard-drawn-copper, CU. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

## 2.7 POLES AND HARDWARE

Poles shall be of lengths and classes indicated.

### 2.7.1 Wood Poles

Wood poles shall comply with ANSI O5.1, and shall be pressure treated in accordance with AWPA C4, and waterborne preservatives conforming to AWPA P5.

Waterborne preservatives shall be either chromated or ammoniacal copper arsenate. Any species listed in ANSI O5.1 for which a preservative treatment is not specified in AWPA C4, shall not be used; northern white cedar, if treated as specified for western red cedar, and western fir, if treated as specified for Douglas fir, may be used. Wood poles shall have pole markings located approximately 10 feet from pole butts for poles 50 feet or less in length, and 14 feet from the pole butts for poles longer than 55 feet in length. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, galled, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

### 2.7.2 Pole Line Hardware

Zinc-coated hardware shall comply with ANSI C135.1, ANSI C135.2, ANSI C135.4, ANSI C135.14 ANSI C135.22. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M. Pole-line hardware shall be hot-dip galvanized steel. Washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16 inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators.

### 2.7.3 Armless Construction

Pole mounting brackets for line-post or pin insulators and eye bolts for suspension insulators shall be as shown. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to ANSI C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pound cantilever strength.

### 2.7.4 Guy Assemblies

Guy assemblies shall be zinc-coated steel in accordance with ASTM A 475. Guy assemblies, including insulators and attachments, shall provide a

strength exceeding the required guy strength. Three-eye thimbles shall be provided on anchor rods to permit attachment of individual primary, secondary, and communication down guys. Anchors shall provide adequate strength to support all loads. Guy strand shall be 7 strand. Guy material shall be zinc-coated-steel extra-high-strength, with a minimum breaking strength not less than 12,000 pounds, except where two or more guys are used to provide the required strength. Guy rods shall be not less than 8 feet in length by 1 inch in diameter.

## 2.8 INSULATORS

Insulators shall comply with NEMA HV 2 for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

### 2.8.1 Medium-Voltage Line Insulators

Medium-voltage line insulators shall comply with ANSI C29.2, ANSI C29.5, and ANSI C29.6, and as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.

TABLE I

MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
Up to 5 kV	57-1 or 11	55-3	One 52-1
	57-1 or 11	55-5	Two 52-1

### 2.8.2 Low-Voltage Line Insulators

Low-voltage line insulators shall comply with ANSI C29.2 and ANSI C29.3 as applicable. Spool insulators for use on low-voltage lines shall be mounted on clevis attachments or secondary racks and shall be not smaller than Class 53-3. Suspension insulators on clevis attachments used at dead-ends shall be not smaller than Class 52-1.

### 2.8.3 Strain Insulators for Guy Wires

Strain insulators for use in insulated guy assemblies shall comply with ANSI C29.4 for porcelain or equivalent fiberglass, and shall have a mechanical strength exceeding the rated breaking strength of the attached guy wire. Insulators shall be not smaller than Class 54-3 for lines of 6 kV.

#### 2.8.4 Apparatus Insulators

Apparatus insulators shall comply with IEEE C57.19.00, IEEE C57.19.01, ANSI C29.8, and ANSI C29.9 as applicable.

### 2.9 CROSSARM ASSEMBLIES

#### 2.9.1 Crossarms

Crossarms shall comply with RUS REA Bull 1728H-701 and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWP A C25, and a 1/4 inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 8 feet in length, except that 10 foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10 inch per foot of length. Bend or twist shall be in one direction only.

#### 2.10 FUSES AND SWITCHES, MEDIUM-VOLTAGE

##### 2.10.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the loadbreak open type construction rated 15 kV and of the heavy. Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

#### 2.11 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, and IEEE C62.11, and shall be provided for protection of aerial-to-underground transitions, automatic circuit reclosers, capacitor equipment, group-operated load-interrupter switches, transformers and other indicated equipment. Arresters shall be distribution class, rated 6 KV. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type suitable for outdoor installations.

#### 2.12 GROUNDING AND BONDING

##### 2.12.1 Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

##### 2.12.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that

conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

### PART 3 EXECUTION

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Secondary circuits installed in conduit on poles shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

##### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of IEEE C2 for medium loading districts, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of NFPA 70.

##### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

#### 3.2 POLE INSTALLATION

Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be wood poles utilizing armless and crossarm construction. Crossarm construction shall be provided for support of other equipment. Provision for communication services is required on pole-line construction, except where specifically noted otherwise. A vertical pole space of not less than 2 feet shall be reserved at all locations.

##### 3.2.1 Wood Pole Setting

Wood Pole Setting: Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. In rocky or swampy ground, pole-setting depths shall be decreased or increased as shown. In swampy or soft ground, a bog shoe shall be used where support for a pole is required. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations, and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into the hole in 6 inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus

earth shall be placed around each pole in a conical shape and packed tightly to drain water away from poles.

TABLE II

## MINIMUM POLE-SETTING DEPTH (FEET)

Length Overall Feet	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5.0	5.0
25	5.5	5.5
30	5.5	5.5
35	6.0	6.0
40	6.5	6.5
45	6.5	7.0
50	7.0	7.5
55	7.5	8.0
60	8.0	8.5

## 3.3 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 5/8 inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8 inch nor more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces may be provided for 8 foot crossarms and shall be 1/4 by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8 inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2 by 4 inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10 foot crossarms and shall be 60 inch span by 18 inch drop formed in one piece from 1-1/2 by 1-1/2 by 3/16 inch angle. Angle braces shall be bolted to crossarms with 1/2 inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8 inch through-bolts. Double crossarms shall be securely held in position by means of 5/8 inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

## 3.3.1 Line Arms and Buck Arms

Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buckarms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not attached to the same pole cross each other.

## 3.3.2 Equipment Arms

Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

### 3.4 GUY INSTALLATION

Guys shall be provided where shown, with loads and strengths as indicated, and wherever conductor tensions are not balanced, such as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8 inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. Guy-strain insulators shall be provided in each guy for wood poles. Multiple-helix screw anchors shall be provided in marshy ground; rock anchors shall be installed in rock at right angles to guys, elsewhere anchors shall be of an expanding type, except that power installed screw anchors of equivalent holding power are acceptable. A half-round yellow polyvinyl, fiberglass, or other suitable plastic guy marker, not less than 8 feet in length, shall be provided at the anchor end of each guy shown, securely clamped to the guy or anchor at the bottom and top of the marker. Holding capacities for down guys shall be based on a lead angle of 45 degrees.

### 3.5 CONDUCTOR INSTALLATION

#### 3.5.1 Line Conductors

Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall not be less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation as recommended by the manufacturer.

#### 3.5.2 Connectors and Splices

Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation, when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper.

### 3.5.3 Conductor-To-Insulator Attachments

Conductors shall be attached to insulators by means of clamps, shoes or tie wires, in accordance with the type of insulator. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in TABLE II.

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any size	6 or 4

### 3.5.4 Armor Rods

Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

### 3.6 CONNECTIONS TO UTILITY LINES

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the utility electric lines.

### 3.7 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to poles by conduit supports spaced not more than 10 feet apart and with one support not more than 12 inches from any bend or termination. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the riser conduit or guard. Cables guards shall be secured in accordance with the manufacturers published procedure. Risers shall be equipped with bushings to protect cables. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable.

### 3.8 GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such

as luminaires, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, panel enclosures, transformers, capacitors, recloser frames (cases) and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where indicated.

### 3.8.1 Grounding Electrodes

Grounding electrodes shall be installed as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 3 feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together 2 feet below grade with a minimum No. 6 bare copper conductor.
- B. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 5 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of 10 feet apart driven perpendicular to grade. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 5 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.8.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

### 3.8.3 Grounding Electrode Conductors

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. For single grounded or ungrounded systems, provide a grounding conductor for the surge arrester and equipment grounding conductors and a separate grounding conductor for the secondary neutrals. Grounding electrode conductors shall be sized as shown. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor, as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet. On metal poles, a preformed galvanized steel strap, 5/8 inch wide by 22 gauge minimum by length, secured by a preformed locking method standard with the manufacturer, shall be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 5 feet with one band not more than 3 inches from

each end of the vertical grounding electrode conductor. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

### 3.9 FIELD TESTING

#### 3.9.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

Field reports will be signed and dated by the Contractor.

#### 3.9.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.9.3 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

#### 3.9.4 Sag and Tension Test

The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

#### 3.9.5 Pre-Energization Services

The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and to ensure that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first

electrical operation.

### 3.9.6 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

### 3.10 MANUFACTURER'S FIELD SERVICE

#### 3.10.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 2 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

#### 3.10.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.11 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

## SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND  
02/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C119.1	(1986; R 1997) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C12.10	(1997) Electromechanical Watthour Meters
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C37.121	(1989; R 1995) Switchgear, Unit Substations Requirements
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C37.72	(1987) Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems
ANSI C57.12.13	(1982) Conformance Requirements for Liquid-Filled Transformers Used in Unit Installations, Including Unit Substations
ANSI C57.12.27	(1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations
ANSI C57.12.28	(1999) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity
ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2001) Zinc (Hot-Dip Galvanized) Coatings
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	on Iron and Steel Products
ASTM A 153/A 153M	(2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 48	(1994ae1) Gray Iron Castings
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 3	(1995) Soft or Annealed Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography
ASTM D 923	(1997) Sampling Electrical Insulating Liquids
ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)	
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV
FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)	
FM P7825a	(1998) Approval Guide Fire Protection
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE C2	(2000) National Electrical Safety Code
IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.20.2	(1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear
IEEE C37.20.3	(1997) Metal-Enclosed Interrupter Switchgear
IEEE C37.23	(1987; R 1991) Guide for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus
IEEE C37.30	(1997) Requirements for High-Voltage Switches
IEEE C37.34	(1994) Test Code for High-Voltage Air

## Switches

- IEEE C37.41 (1994; C37.41c) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
- IEEE C37.63 (1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
- IEEE C57.12.00 (1993) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- IEEE C57.13 (1993) Instrument Transformers
- IEEE C57.98 (1993) Guide for Transformer Impulse Tests \\\\$avail only as part of Distribution, Power, and Regulating Transformers Stds Collection
- IEEE C62.1 (1989; R 1994) Surge Arresters for AC Power Circuits
- IEEE C62.11 (1999) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
- IEEE C62.2 (1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
- IEEE Std 100 (1997) IEEE Standard Dictionary of Electrical and Electronics Terms
- IEEE Std 242 (1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- IEEE Std 386 (1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
- IEEE Std 399 (1997) Recommended Practice for Industrial and Commercial Power Systems Analysis
- IEEE Std 404 (1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
- IEEE Std 48 (1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
- IEEE Std 592 (1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) \ \$31.00\$ \ F

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA BU 1 (1994) Busways

NEMA FB 1 (1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

NEMA LA 1 (1992) Surge Arresters

NEMA SG 2 (1993) High Voltage Fuses

NEMA TC 6 (1990) PVC and ABS Plastic Utilities Duct for Underground Installation

NEMA WC 8 (1988; Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 1072 (1995; Rev Mar 1998) Medium Voltage Power Cables

UL 1242 (1996; Rev Mar 1998) Intermediate Metal Conduit

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL 486A (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors

UL 510 (1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

UL 514A (1996; Rev Dec 1999) Metallic Outlet Boxes

UL 6 (1997) Rigid Metal Conduit

UL 651 (1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit

UL 857

(1994; Rev thru Dec 1999) Busways and  
Associated Fittings

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

### 1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

- b. Altitude 10 feet
- c. Ambient Temperature 95 degrees F
- d. Frequency 60

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Electrical Distribution System; G, AE

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

- a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for

installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

c. Substations.

d. Switchgear.

e. Pad-mounted loadbreak switches.

g. Surge arresters.

#### As-Built Drawings; G

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

Fault Current Analysis; G, AE

Protective Device; G, AE

Coordination Study; G, AE

The study shall be submitted with protective device equipment submittals. No time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings,

or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Nameplates; G, AE

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G, AE.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

General Installation Requirements; G, AE.

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

#### SD-06 Test Reports

Factory Tests; G, AE

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; G,

A proposed field test plan, 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; G,

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.

- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Cable Installation; G,

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Material and Equipment; G,

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with

any other requirements of the specifications.

Cable Joints; G,

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications; G,

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

#### SD-10 Operation and Maintenance Data

Electrical Distribution System; G,

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when

received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 NAMEPLATES

##### 2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

##### 2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 2 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 2 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted. Nameplates shall be stainless steel.

#### 2.3 CORROSION PROTECTION

##### 2.3.1 Aluminum Materials

Aluminum shall not be used.

### 2.3.2 Ferrous Metal Materials

#### 2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

#### 2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTS AND COATINGS.

### 2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

#### 2.4.1 Medium-Voltage Cables

##### 2.4.1.1 General

Cable construction shall be Type MV, conforming to NFPA 70 and UL 1072 . Cables shall be manufactured for use in duct applications .

##### 2.4.1.2 Ratings

Cables shall be rated for a circuit voltage 35 kV.

##### 2.4.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric stranding.

##### 2.4.1.4 Insulation

Cable insulation shall be ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6. A 100 percent insulation level shall be used on 35 kV rated cables.

##### 2.4.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase. The shield tape shall be sized to meet IEEE C2

requirements for a ground fault availability of 20,000 amperes.

#### 2.4.1.6 Jackets

Cables shall be provided with a polyethylene jacket. Direct buried cables shall be rated for direct burial.

#### 2.4.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

##### 2.4.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8. Intermixing of copper and aluminum conductors is not permitted.

##### 2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

##### 2.4.2.3 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

#### 2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

##### 2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592.

Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the premolded splice and connector type, or the resin pressure-filled overcast type for voltages up to 35 kV. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

##### 2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

##### 2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the

applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B.

Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

#### 2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type. Class 2 and 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

##### 2.5.4.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level. Anti-tracking tape shall be applied over exposed insulation of preformed molded elastomer terminations.

##### 2.5.4.2 Taped Terminations

Taped terminations are not acceptable.

#### 2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be concrete-encased, thin-wall type.

##### 2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

##### 2.6.2 Nonmetallic Ducts

###### 2.6.2.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

###### 2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

## 2.7 MANHOLES, HANDHOLES, AND PULLBOXES

Manholes, handholes, and pullboxes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers. Manhole, handhole and pullbox sizes shall be as indicated

## 2.8 TRANSFORMERS, SUBSTATIONS, AND SWITCHGEAR

Transformers, substations, and switchgear shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 35 kV between phases for 100 percent insulation level.

### 2.8.1 Secondary Unit Substation

Secondary unit substations shall comply with ANSI C37.121 and shall be of the radial type. Substations shall be subassembled and coordinated by one manufacturer and shall be shipped in complete sections ready for connection at the site. Complete sections shall include incoming, transformer, and outgoing sections and, where practicable, shall be shipped as one unit.

#### 2.8.1.1 Incoming Section

Metal-enclosed interrupter switchgear consisting of fused, air-insulated, interrupters in series with automatic, visible blade disconnects shall be provided for protection of incoming circuits. . Metal-enclosed interrupter switchgear shall comply with IEEE C37.30 for load-interrupter switches, NEMA SG 2 for power fuses, and shall be of the outdoor no-aisle type that meets or exceeds the requirements of applicable publications listed. Switch construction shall be of the manually-operated, "OPEN-CLOSED," air-insulated, load interrupter type equipped with a stored energy operator for quick-make quick-break to make operating speeds independent of manual switch operations. Where indicated, suitable bus or lug connections shall be provided to mount field-installed, slip-on, medium-voltage cable terminations for cable entering via conduit from below and a flanged throat suitable for direct connection to the associated transformer . Surge protection shall be provided in accordance with

paragraph SURGE ARRESTERS. Switches shall be of the 2-position type, open-closed.

- a. Ratings. Fuse continuous current ratings shall be as indicated for the transformer for an incoming line unit and for the line tie unit. Unless otherwise indicated, fuses shall be of the current limiting type. Switch ratings at 60 Hz shall be:

Nominal voltage.....	25.
Rated maximum voltage.....	25.
Maximum symmetrical interrupting capacity.....	26,000.
Maximum asymmetrical interrupting capacity.....	26,000.
Rated continuous current.....	600.
BIL.....	150.

- b. Basic Requirements. The electrical devices listed below shall be rated for the application and voltage and current indicated. Unless otherwise noted, manufacturer's standard devices shall be provided and shall include the following:

- (1) A switch-operating handle with provisions for locking in either the open or closed position.
- (2) A switch mechanical position indicator.
- (3) A heater continuously energized to prevent condensation over an ambient temperature range of minus 20 degrees F to 40 degrees F at 90% relative humidity and wired in series with a cabinet door-actuated switch, so the heater is de-energized when doors are open. High-temperature thermal protection shall be included.
- (4) One-pole or 2-pole thermal-magnetic, molded-case circuit breakers suitable for the operating voltage for heater circuits.
- (5) Safety devices as necessary to ensure that the load interrupter switch is in the open position whenever unit doors are in the open position.
- (6) A key interlock if indicated.
- (7) An interface terminal block wired for required exterior connections.

2.8.1.2 Transformer Section

Transformers shall have two separate windings per phase and shall be of the mineral oil-insulated type with high molecular-weight hydrocarbon or dimethyl silicone liquid. Transformers shall be suitable for outdoor use. Liquid-insulated transformers shall comply with IEEE C57.12.00, ANSI C57.12.13, and ANSI C57.12.27, and shall have two 2-1/2 percent full capacity taps above and two 2-1/2 percent full capacity taps below rated voltage. Transformers shall be of the sealed tank type construction with welded-on cover. High-voltage terminals shall be provided for direct connection to the incoming line section. Low-voltage terminals shall be

provided for direct connection to the outgoing switchgear section. Low-voltage terminals shall be as shown on the drawings when facing the front, accessory side of the transformer. Transformer accessories and ratings at 60 Hz shall be as follows:

Three-phase capacity, self-cooled.....3000 kVA.  
 Impedance..5.75 percent, standard minimum.  
 Temperature rise.....65 degrees C.  
 High-voltage winding.....22,000 volts.  
 High-voltage winding connection.....Delta.  
 Low-voltage winding.....480Y/277 volts.  
 Low-voltage winding connection.....wye.

Accessories:

- a. drain and filter connection.
- b. filling and top filter press connection.
- c. pressure-vacuum gauge.
- d. dial type thermometer with alarm contacts.
- e. magnetic liquid level indicator with high and low level alarm contacts.
- f. pressure relief device with alarm contacts.
- g. ground connection pad.
- h. provision for jacking, lifting, and towing.
- i. diagram and rating nameplate.

2.8.1.3 Integral Outgoing Section

Integral outgoing section shall be of the busway throat connection to a metering and cabling termination compartment type. Each terminal compartment shall have a suitable metal or laminated plastic nameplate with white cut letters at least 1/4 inch high on contrasting backgrounds .

- a. Busway Throat Connection Terminal Compartment Type: Weatherproof Outgoing section shall consist of an enclosure containing metering devices on the main secondary circuit and connections from transformer terminals to suitable busway throats provided for connections to cable installations entering . Connection to porcelain bushings shall be made with flexible jumpers.
- d. Metering: The main secondary bus of each outgoing section assembly shall include a watthour demand meter with the necessary instrument transformers, and VT and CT test blocks. Metering shall be as specified in paragraph METERING AND PROTECTIVE DEVICES.

2.8.2 Busways

Busways shall comply with NEMA BU 1 and UL 857 and shall be of the voltage, phase, and continuous current ratings required. Neutrals shall be full size.

Busways shall have short-circuit ratings not less than the maximum short-circuit currents of associated transformers, assuming primary sources of infinite capacity. Busways shall be feeder-low-impedance type and of outdoor or indoor service construction as suitable to the location. Busways shall be complete with elbows, fittings, flanges, end-closures, tees, crosses, cable-tap boxes, accessories, and other devices required for the indicated installation, and shall be coordinated for connection to the indicated equipment. For wet/damp locations, bus duct shall be heated, nonventilated enclosure, nonsegregated phase type in accordance with IEEE C37.23. Detail drawings for busway supports and bracing shall be submitted in accordance with the detail drawings portion of paragraph SUBMITTALS and shall indicate that busways are adequately supported for the seismic forces specified in paragraph GENERAL REQUIREMENTS (sub-paragraph Service Conditions).

2.8.3 Pad-Mounted, Metal-Enclosed, Switchgear Addition to existing main station)

The switchgear shall be configured with one distribution compartment , equipped with air-insulated, load-interrupter switches and fused disconnects, for connection to the existing switchgear station and as indicated. Existing switchgear station is manufacturers by S&C. The new additional switchgear section shall be completely compatible with the existing switchgear station. The contractor shall become extend all main existing bussing as required and make all required modifications for a complete installation.

2.8.3.1 Ratings at 60 Hz shall be:

Nominal voltage (kV).....	35.
Rated maximum voltage (kV).....	35.
Rated continuous current (A).....	1200.
Maximum symmetrical interrupting capacity (kA).....	27,000.
Maximum asymmetrical interrupting capacity (kA).....	27,000.
BIL (kV).....	150.

2.8.3.2 Operators, Devices, and Controls

Operators and controls shall be provided for the switchgear as follows:

- a. Switches shall be provided with an operator that matches the existing main switchgear.

2.8.3.3 Enclosures

Switchgear enclosures shall be of freestanding, self-supporting construction provided with separate incoming and outgoing compartments

configured for bottom cable entry. Enclosures shall be of deadfront construction, provided with a hinged door for access to each compartment, and conform to the requirements of ANSI C57.12.28, ANSI C37.72, and IEEE C37.20.3, Category A.

2.8.4 Pad-Mounted Sectionalizers (4 WAY SWITCH)

Pad-mounted, sectionalizing switches shall conform to the requirements of IEEE C37.63. The switchgear shall be configured with 4 incoming compartments for loop-feed arrangement equipped with air-insulated, load-interrupter switches. The switch shall be a low profile type and shall not exceed 50 inches in overall height.

2.8.4.1 Ratings

Ratings at 60 Hz shall be:

Nominal voltage (kV).....	25.
Rated maximum voltage (kV).....	25.
Rated continuous current (A).....	600.
Three-second short-time current-carrying capacity (kA).....	20.
BIL (kV).....	150.
Surge Arresters.....	27 KV.

2.8.4.2 Enclosures

Switchgear enclosures shall be of freestanding, self-supporting construction provided with separate incoming and outgoing compartments configured for bottom cable entry. Enclosures shall be of deadfront construction, provided with a hinged door for access to each compartment, and conform to the requirements of ANSI C57.12.28, ANSI C37.72, and IEEE C37.20.3, Category A.

2.9 METERING AND PROTECTIVE DEVICES

2.9.1 Fuses, Medium-Voltage, Including Current-Limiting

2.9.1.1 Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2.9.1.2 Ratings

Current-limiting power fuses shall have ratings in accordance with ANSI C37.46 and as follows:

Nominal voltage.....	25.
Rated maximum voltage.....	25.
Maximum symmetrical interrupting capacity.....	20,000.
Rated continuous current.....	150.

BIL.....150.

#### 2.9.1.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

#### 2.9.1.4 C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

### 2.9.2 Instrument Transformers

#### 2.9.2.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

#### 2.9.2.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall not be less than 2.0. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accident open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

#### 2.9.2.3 Current Transformers for Power Transformers

Single-ratio bushing type current transformers shall be provided internally around power transformer bushings as shown. Single-ratio units shall have a minimum relaying accuracy class of 0.3B-0.5.

#### 2.9.2.4 Current Transformers for Metal-Enclosed Switchgear

Single-ratio units, used for metering and relaying, shall have a metering accuracy class rating of 0.38 B.1.8. Single-ratio units, used only for relaying, shall have a relaying accuracy class rating of B-0.5 for either a C or T classification.

#### 2.9.2.5 Current Transformers for Kwh and Demand Metering (Low-Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through B-1.8, with a minimum RF of 1.33 at 30 degrees C, with 600-volt insulations, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted in the current transformer cabinet terminal compartment.

#### 2.9.2.6 Voltage Transformers

Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of 0.3. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.

#### 2.9.3 Watthour Meters

Watthour meters shall conform to ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 15 minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than 2-1/2 stators. Watthour demand meters shall have factory-installed electronic pulse initiators. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of 1 pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.

#### 2.10 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be intermediate class, rated 27kV. Arresters for use at elevations in excess of 6000 feet above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type.

#### 2.11 GROUNDING AND BONDING

##### 2.11.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 5/8 inch in diameter by 10 feet in length. Sectional type rods may be used.

##### 2.11.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

#### 2.12 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200A CONCRETE REINFORCEMENT.

### 2.13 PADLOCKS

Padlocks shall comply with Section 08710 DOOR HARDWARE.

### 2.14 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

#### 2.14.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

#### 2.14.2 Fireproofing Tape

Fireproofing tape shall be at least 2 inches wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

#### 2.14.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 10 mil thick, conforming to UL 510.

### 2.15 LIQUID DIELECTRICS

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 2 parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 2 ppm shall be replaced.

### 2.16 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 21 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

- a. Transformers: Manufacturer's standard routine and design and other tests in accordance with IEEE C57.12.00.

- b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE C57.98.
- c. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE C37.34 and IEEE C37.41.
- f. Instrument Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.
- g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.
- h. Outdoor Switchgear: Manufacturer's standard tests in accordance with IEEE C37.20.1, IEEE C37.20.2, and IEEE C37.20.3.
- i. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

## 2.17 FENCING

Fencing shall conform to the requirements of Section 02821A FENCING.

## 2.18 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

### 2.18.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus (primary 22 kV system) and extend down to system bused where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

### 2.18.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall coordinate with the base electrical engineer for fault current availability at the site.

### 2.18.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance

diagram is provided, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

#### 2.18.4 Fault Current Analysis

##### 2.18.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

##### 2.18.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

#### 2.18.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and any relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

#### 2.18.6 Study Report

- a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. The report shall document utility company data including system voltages, fault MVA, and system X/R ratio.
- d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.
- e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415A ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316A EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 4000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 3.1.3 Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

### 3.2 CABLE AND BUSWAY INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturer's instructions in accordance with SUBMITTALS.

#### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

##### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture

shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size

of conductor.

k. Maximum allowable pulling tension on pulling device.

### 3.2.2 Duct Line

Cables shall be installed in duct lines . Cable splices in low-voltage cables shall be made in manholes only. Cable joints in medium-voltage cables shall be made in manholes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

### 3.2.3 Insect and Rodent Damage

Animal guards shall be installed on all subsurface equipment, structures, conduit and ducts.

### 3.2.4 Manholes

Cables shall be routed around the interior walls at least one complete full length of the inside perimeter, and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

### 3.2.5 Busway Installation

Busways penetrating walls shall have wall flanges installed on both surfaces of walls. Wall openings shall be approximately 1/4 inch larger than the busway on each of the 4 busway sides, and openings shall be sealed with a suitable compound. Fire barriers shall be provided when penetrating fire rated walls. Fire barriers shall have a rating equal to the fire wall rating. A weather barrier shall be used when a busway penetrates an exterior wall. Busways shall be supported at intervals not exceeding 10 feet and shall be braced to prevent lateral movement.

## 3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

## 3.4 FIREPROOFING

Each medium-voltage cable and conductor in manholes shall be fire-proofed for their entire length within the manhole. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed in the manhole before fireproofing. Fire-stops shall be installed in each conduit entering or leaving a manhole.

### 3.4.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering the joints of the first.

### 3.5 DUCT LINES

#### 3.5.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

#### 3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.5.3 Concrete Encasement

Ducts shall be concrete encased and shall comply with NFPA 70, except that electrical duct banks shall be covered a minimum of 24 inches below finished grade from top of upper duct(s). The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement

during the placement of concrete and joints shall be staggered at least 6 inches vertically.

#### 3.5.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

##### 3.5.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

#### 3.5.5 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

### 3.6 MANHOLES, HANDHOLES, AND PULLBOXES

#### 3.6.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

### 3.6.2 Electric Power Manholes

Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks. Provide two racks per wall minimum.

### 3.6.3 Communications Manholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone manhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others. See additional details on the drawings.

### 3.6.4 Handholes

Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

### 3.6.5 Ground Rods

A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

## 3.7 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase transformers shall be installed with ABC phase sequence. Primary taps shall be set at 0.

### 3.7.1 Concrete Pads

#### 3.7.1.1 Construction

Concrete pads for pad-mounted electrical equipment shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed

through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

#### 3.7.1.2 Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200A CONCRETE REINFORCEMENT.

#### 3.7.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

#### 3.7.2 Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed as directed by the Contracting Officer.

### 3.8 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 10 feet apart and with 1 strap not more than 12 inches from any bend or termination. Cable guards shall be secured to poles in accordance with the manufacturer's published procedures. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the conduit or guard.

#### 3.8.1 Pole Installation

Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

### 3.9 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and 2 feet below finished grade as specified and provided under Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

### 3.10 GROUNDING

A ground ring consisting of the indicated configuration of bare copper

conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer, a switchgear ground bus, and a unit substation to the ground mat. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

#### 3.10.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.
- c. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 30 inches, below finished top of soil grade. Ground ring conductors shall be sized as shown.
- d. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of 10 feet apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 10 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

#### 3.10.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

#### 3.10.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

#### 3.10.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

### 3.10.5 Manhole, Handhole, or Concrete Pullbox Grounding

Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

### 3.10.6 Metal Splice Case Grounding

Metal splice cases for medium-voltage direct-burial cable shall be grounded by connection to a driven ground rod located within 2 feet of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

### 3.10.7 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 2 feet.

## 3.11 FIELD TESTING

### 3.11.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

### 3.11.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.11.3 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance

measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 5 ohms.
- b. Multiple rod electrodes - 5 ohms.
- d. Ground ring - 1 ohms.

#### 3.11.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 8 for the particular type of cable installed, except that 35 kV insulation test voltages shall be in accordance with either AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

#### 3.11.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$$

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

#### 3.11.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- c. Correct phase sequence.
- d. Correct operation of tap changer.

### 3.11.7 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

- a. Secondary unit substation
- b. Pad-mounted switches and switchgear
- e. Metal-enclosed switchgear
- f. Busways
- g. Switches

### 3.11.8 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

## 3.12 MANUFACTURER'S FIELD SERVICE

### 3.12.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The

course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

### 3.12.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.13 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

## SECTION 16415

ELECTRICAL WORK, INTERIOR  
06/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.16	(2000) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C78.1	(1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.1350	(1990) Electric Lamps - 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) Electric Lamps - 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) Electric Lamps - 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) Electric Lamps - 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C78.1375	(1996) 400-Watt, M59 Single-Ended Metal-Halide Lamps
ANSI C78.1376	(1996) 1000-Watt, M47 Metal-Halide Lamps
ANSI C78.20	(1995) Electric Lamps - Characteristics of Incandescent Lamps A, G, PS, and Similar Shapes with E26 Medium Screw Bases
ANSI C78.21	(1995) Physical and Electrical Characteristics - Incandescent Lamps - PAR and R Shapes
ANSI C78.2A	(1991) 18 & 26- Watt, Compact Fluorescent Quad Tube Lamps **
ANSI C78.2B	(1992) 9 & 13-Watt, Compact Fluorescent

## Quad Tube Lamps \*\*

- ANSI C82.1 (1997) Specifications for Fluorescent Lamp Ballasts \F\X Addenda D & E
- ANSI C82.4 (1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM B 1 (1995) Hard-Drawn Copper Wire
- ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- ASTM D 709 (2000) Laminated Thermosetting Materials

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE C37.13 (1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
- IEEE C57.13 (1993) Instrument Transformers
- IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
- IEEE Std 242 (1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- IEEE Std 399 (1997) Recommended Practice for Industrial and Commercial Power Systems Analysis
- IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) \F

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA 250 (1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
- NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches
- NEMA FU 1 (1986) Low Voltage Cartridge Fuses
- NEMA ICS 1 (1993) Industrial Control and Systems
- NEMA ICS 2 (1993) Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
- NEMA ICS 3 (1993) Industrial Control and Systems Factory Built Assemblies

NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility
NEMA MG 1	(1998) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA RN 1	(1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA SG 3	(1995) Power Switching Equipment
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1998) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA VE 1	(1996) Metal Cable Tray Systems
NEMA WD 1	(1999) General Requirements for Wiring Devices
NEMA WD 6	(1997) Wiring Devices - Dimensional Requirements

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2000) Life Safety Code
NFPA 70	(2002) National Electrical Code

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 18	Industrial, Scientific, and Medical Equipment
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## UNDERWRITERS LABORATORIES (UL)

UL 1	(2000) Flexible Metal Conduit
UL 1004	(1994; Rev thru Nov 1999) Electric Motors
UL 1010	(1995; Rev thru Mar 1999) Receptical-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1022	(1998) Line Isolation Monitors

UL 1029 (1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts

UL 1047 (1995; Rev Jul 1998) Isolated Power Systems Equipment

UL 1242 (1996; Rev Mar 1998) Intermediate Metal Conduit

UL 1449 (1996; Rev thru Dec 1999) Transient Voltage Surge Suppressors

UL 1564 (1993; R Sep 1998) Industrial Battery Chargers

UL 1569 (1999; Rev thru Jan 2000) Metal-Clad Cables

UL 1570 (1995; Rev thru Nov 1999) Fluorescent Lighting Fixtures

UL 1571 (1995; Rev thru Nov 1999) Incandescent Lighting Fixtures

UL 1572 (1995; Rev thru Nov 1999) High Intensity Discharge Lighting Fixtures

UL 1660 (2000) Liquid-Tight Flexible Nonmetallic Conduit

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 198G (1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection

UL 198L (1995; Rev May 1995) D-C Fuses for Industrial Use

UL 20 (1995; Rev thru Oct 1998) General-Use Snap Switches

UL 360 (1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL 486A (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486C (1997; Rev thru Aug 1998) Splicing Wire Connectors

UL 486E (1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

UL 489 (1996; Rev thru Dec 1998) Molded-Case  
Circuit Breakers, Molded-Case Switches, and  
Circuit-Breaker Enclosures

UL 5 (1996) Surface Metal Raceways and Fittings

UL 50 (1995; Rev thru Nov 1999) Enclosures for  
Electrical Equipment

UL 506 (1994; R Oct 1997) Specialty Transformers

UL 508 (1999) Industrial Control Equipment

UL 510 (1994; Rev thru Apr 1998) Polyvinyl  
Chloride, Polyethylene, and Rubber  
Insulating Tape

UL 512 (1993; Rev thru Mar 1999) Fuseholders

UL 514A (1996; Rev Dec 1999) Metallic Outlet Boxes

UL 514B (1997; Rev Oct 1998) Fittings for Cable and  
Conduit

UL 542 (1999) Lampholders, Starters, and Starter  
Holders for Fluorescent Lamps

UL 6 (1997) Rigid Metal Conduit

UL 651 (1995; Rev thru Oct 1998) Schedule 40 and  
80 Rigid PVC Conduit

UL 67 (1993; Rev thru Oct 1999) Panelboards

UL 674 (1994; Rev thru Oct 1998) Electric Motors  
and Generators for Use in Division 1  
Hazardous (Classified) Locations

UL 698 (1995; Rev thru Mar 1999) Industrial  
Control Equipment for Use in Hazardous  
(Classified) Locations

UL 797 (1993; Rev thru Mar 1997) Electrical  
Metallic Tubing

UL 817 (1994; Rev thru May 1999) Cord Sets and  
Power-

UL 83 (1998; Rev thru Sep 1999)  
Thermoplastic-Insulated Wires and Cables

UL 844 (1995; Rev thru Mar 1999) Electric Lighting  
Fixtures for Use in Hazardous (Classified)  
Locations

UL 845 (1995; Rev thru Nov 1999) Motor Control  
Centers

UL 854	(1996; Rev Oct 1999) Service-Entrance Cables
UL 869A	(1998) Reference Standard for Service Equipment
UL 877	(1993; Rev thru Nov 1999) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Apr 1999) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 924	(1995; Rev thru Oct 97) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Oct 1998) Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 98	(1994; Rev thru Jun 1998) Enclosed and Dead-Front Switches
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory

## 1.2 GENERAL

### 1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

### 1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible.

Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

### 1.2.3 Special Environments

#### 1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

#### 1.2.3.2 Hazardous Locations

Wiring in locations indicated shall conform to the NFPA 70 for Class I , Division 1 hazardous locations. Equipment shall be suitable for Group D

#### 1.2.3.3 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

#### 1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 1.2.5 Nameplates

##### 1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch  
High Letters

Minimum 1/8 inch  
High Letters

Panelboards  
Starters  
Safety Switches  
Motor Control Centers  
Transformers  
Equipment Enclosures  
Switchgear  
Switchboards  
Motors

Control Power Transformers  
Control Devices  
Instrument Transformers

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

#### 1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Interior Electrical Equipment; G, AE.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.
- b. Switchgear.
- c. Battery system including calculations for the battery and charger.
- d. Raised Access Flooring Boxes.
- e. Grounding resistors.
- f. Motors and rotating machinery.
- h. Cable tray systems. Including complete floor plan layouts; indicating exact location of cable trays, fittings, risers, offsets, floor pedestals, in floor boxes, details and all other

devices in or on raised access flooring.

- i. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.
- j. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

#### SD-03 Product Data

Fault Current and Protective Device Coordination Study; G, AE.

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog; G, AE.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient

detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; G, AE.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; G, AE.

Installation procedures for rotating equipment, transformers, switchgear and battery systems. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

As-Built Drawings; G.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; G.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-06 Test Reports

Factory Test Reports; G, AE.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.

- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; G, AE.

A detailed description of the Contractor's proposed procedures for onsite test submitted 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; G, AE.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

SD-07 Certificates

Materials and Equipment; G, AE.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL

label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

#### 1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

#### 1.5 SEISMIC REQUIREMENTS

Seismic details shall 16070A SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

### PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

##### 2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

##### 2.1.2 Aluminum Conductors

Aluminum conductors shall not be used.

##### 2.1.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

##### 2.1.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter;

ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

#### 2.1.5 Service Entrance Cables

Underground service entrance (USE) cables, UL 854.

#### 2.1.6 Metal-Clad Cable (FOR UNDER RAISED ACCESS FLOOR BRANCH CIRCUITS ONLY)

UL 1569; NFPA 70, Type MC cable.

#### 2.1.7 Cord Sets and Power-Supply Cords

UL 817.

### 2.2 CABLE TRAYS

Cable tray shall conform to NEMA VE 1, shall form a wireway system, and shall be of nominal 4 inch depth. Cable trays shall be constructed of aluminum. Trays shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius. Radius of bends shall be 24 inches or as required to fit around raised floor pedestals.

#### 2.2.1 Ladder

Ladder-type cable trays shall be of nominal 18 inch width unless otherwise indicated. Rung spacing shall be on 6 inch maximum centers. Provide all required accessories, bends, t-offs, rises, runs, rise ups, turn down, 45's, 90's, ends, fittings, supports, ground connections, penetration firestopping, etc., for a complete installation.

### 2.3 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL listed and labeled as having been tested in accordance with UL 1449. Surge suppressor voltage ratings shall be volts rms, operating voltage as required for the electrical characteristics installed on; 60 Hz; 3-phase; 4 wire with ground; transient suppression voltage (peak let-through voltage) of 492 volts on 277/489 volt system and 250 volts on 120/208 volt system volts. Fuses shall not be used as surge suppression. Type 1 TVSS where indicated shall comply with all ratings for Category C3 in accordance with IEEE C62.41. Type 2 TVSS where indicated shall comply with all ratings for Category B3 in accordance with IEEE C62.41. All TVSS devices shall comply with UL 1449.

### 2.4 CHARGERS, BATTERY

UL 1564. Battery chargers shall be general purpose, continuous current output, with solid state rectifiers. Means shall be provided to regulate and to adjust the dc output voltage. Chargers shall have continuous current ratings of 10 to 15 percent higher than battery current outputs based upon an 8-hour discharge.

### 2.5 CIRCUIT BREAKERS

#### 2.5.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, , or combination motor controllers. Provide circuit breakers 150 amperes and above for computer with shunt trip coil; 120 VAC.

#### 2.5.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper and aluminum conductors in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

#### 2.5.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

#### 2.5.1.3 Cascade System Ratings

Circuit breakers used in series combinations are not acceptable.

#### 2.5.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 225 amperes.

#### 2.5.2 Solid-State Trip Elements

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with

distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be torodial construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

- a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.
- b. Adjustable long-time delay.
- c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- d. Adjustable short-time delay.
- e. Short-time  $I^2 t$  switch.
- f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but not greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap will not be permitted. n.
- h. Adjustable ground-fault delay.
- i. Ground-fault  $I^2 t$  switch.
- j. short-time and ground-fault trip indicators shall be provided.

### 2.5.3 Current-Limiting Circuit Breakers

Current-limiting circuit breakers shall be provided as shown. Current-limiting circuit breakers shall limit the let-through  $I^2 t$  to a value less than the  $I^2 t$  of one-half cycle of the symmetrical short-circuit current waveform. On fault currents below the threshold of limitation, breakers shall provide conventional overload and short-circuit protection. Integrally-fused circuit breakers shall not be used.

### 2.5.4 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

### 2.5.5 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

### 2.5.6 Low-Voltage Power

- a. Construction:

Low-voltage power circuit breakers shall conform to IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, electrically operated, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed. Control voltage shall be 48 V dc or 120 V dc or 120 VAC. The circuit breaker enclosure shall be suitable for its intended location. Provide coil coordinated operating circuit from a source (transformer, rectifier, etc) in the breaker.

b. Ratings:

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.
2. Adjustable long-time delay.
3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
4. Adjustable short-time delay.
5. Short-time I square times t switch.
6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted.
8. Adjustable ground-fault delay.
9. Ground-fault I square times t switch.
10. short-circuit and ground-fault trip indicators shall be provided.

#### 2.5.7 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

#### 2.6 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination

motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

#### 2.6.1 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

#### 2.6.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA 0	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

#### 2.7 CONDUIT AND TUBING

##### 2.7.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

##### 2.7.2 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

##### 2.7.3 Intermediate Metal Conduit

UL 1242.

##### 2.7.4 PVC Coated Rigid Steel Conduit

NEMA RN 1.

##### 2.7.5 Rigid Metal Conduit

UL 6.

##### 2.7.6 Rigid Plastic Conduit (Below slab only)

NEMA TC 2, UL 651 .

## 2.7.7 Surface Metal Electrical Raceways and Fittings

UL 5.

## 2.8 CONDUIT AND DEVICE BOXES AND FITTINGS

## 2.8.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

## 2.8.2 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

## 2.8.3 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

## 2.8.4 Fittings for Conduit and Outlet Boxes

UL 514B.

## 2.8.5 Fittings For Use in Hazardous (Classified) Locations

UL 886.

## 2.8.6 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

## 2.9 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

## 2.10 CONNECTORS, WIRE PRESSURE

## 2.10.1 For Use With Copper Conductors

UL 486A.

## 2.11 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

## 2.11.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

## 2.11.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

## 2.12 ENCLOSURES

NEMA ICS 6 or NEMA 250 or UL 698 for use in hazardous (classified)

locations, unless otherwise specified.

#### 2.12.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

#### 2.12.2 Circuit Breaker Enclosures

UL 489.

#### 2.12.3 Circuit Breaker Enclosures for Use in Hazardous (Classified) Locations

UL 877.

### 2.13 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lighting equipment installed in classified hazardous locations shall conform to UL 844. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below.

#### 2.13.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

- a. Incandescent and tungsten halogen lamps shall be designed for 125 volt operation (except for low voltage lamps), shall be rated for minimum life of 2,000 hours, and shall have color temperature between 2,800 and 3,200 degrees Kelvin. Tungsten halogen lamps shall incorporate quartz capsule construction. Lamps shall comply with ANSI C78.20 and sections 238 and 270 of ANSI C78.21.
- b. Fluorescent lamps shall be green-tipped and shall have color temperature 3,500 degrees Kelvin. They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens
T8/U,31-32 watts	(U-tube)	2600 lumens
T12/U,34 watts	(U-tube)	2700 lumens

- (1) Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 75. Lamps of other lengths or types shall be used only where specified or shown. Lamps shall deliver rated life when operated on rapid start

ballasts .

(2) Small compact fluorescent lamps shall be twin, double, or triple tube configuration as shown with bi-pin or four-pin snap-in base and shall have minimum CRI of 85. They shall deliver rated life when operated on ballasts as shown. 9 and 13 watt double tube lamps shall comply with ANSI C78.2B. 18 and 26 watt double tube lamps shall comply with ANSI C78.2A. Minimum starting temperature shall be 32 degrees F for twin tube lamps and for double and triple twin tube lamps without internal starter; and 15 degrees F for double and triple twin tube lamps with internal starter.

(3) Long compact fluorescent lamps shall be 18, 27, 39, 40, 50, or 55 watt bi-axial type as shown with four-pin snap-in base; shall have minimum CRI of 85; and shall have a minimum starting temperature of 50 degrees F. They shall deliver rated life when operated on rapid start ballasts .

- c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1350, ANSI C78.1351, ANSI C78.1352, ANSI C78.1355, ANSI C78.1375, and ANSI C78.1376.

#### 2.13.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

- a. Low voltage incandescent transformers shall be Class II UL listed 120/12 volt or 120/24 volt step-down transformers as required for the lamps shown. Transformers shall be high power factor type and shall be rated for continuous operation under the specified load. Transformers shall be encased or encased and potted, and mounted integrally within the lighting fixture unless otherwise shown.
- b. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless otherwise shown. Ballasts shall have maximum current crest factor of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture. A single ballast may be used to serve multiple fixtures if they are continuously mounted, identically controlled and factory manufactured for that installation with an integral wireway.

- (1) Compact fluorescent ballasts shall comply with IEEE C62.41

Category A transient voltage variation requirements and shall be mounted integrally within compact fluorescent fixture housing unless otherwise shown. Ballasts shall have minimum ballast factor of 0.95; maximum current crest factor of 1.6; high power factor; maximum operating case temperature of 77 degrees F above ambient; shall be rated Class P; and shall have a sound rating of Class A. Ballasts shall meet FCC Class A specifications for EMI/RFI emissions. Ballasts shall operate from nominal line voltage of 120 or 277 volts at 60 Hz and maintain constant light output over a line voltage variation of  $\pm 10\%$ . Ballasts shall have an end-of-lamp-life detection and shut-down circuit. Ballasts shall be UL listed and shall contain no PCBs. Ballasts shall contain potting to secure PC board, provide lead strain relief, and provide a moisture barrier.

(2) Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 50 degrees F or as shown. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum \$10 labor allowance per ballast.

## ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid start	120 or 277 V	1	2.54
	linear & U-tubes		2	1.44
			3	0.93
			4	0.73
34W T12	rapid start	120 or 277 V	1	2.64
	linear & U-tubes		2	1.41
			3	0.93
59W T8	rapid start linear	120 or 277 V	2	0.80
60W T12	rapid start linear	120 or 277 V	2	0.80

(3) Magnetic fluorescent ballasts shall be energy-saving, automatic resetting type, approved for the application by the Certified Ballast Manufacturers and complying with ANSI C82.1 and UL 935. Minimum ballast starting temperature shall be 40 degrees F

for normal service and 0 degrees F where cold temperature service is required. Magnetic fluorescent ballasts shall have a ballast factor not less than shown in the following table:

## MAGNETIC FLUORESCENT BALLAST FACTORS\*

Design starting temperature above 40 degrees F with 60 Hz input frequency

LAMP TYPE	NUMBER OF LAMPS	NOMINAL OPERATIONAL INPUT VOLTAGE	TYPE OF STARTER & LAMP	MIN. BALLAST FACTOR
25W F25T8	1	120v	rapid start	.96
	1	277v		.96
	2	120v		.95
	2	277v		.94
32W F32T8	1	120v	rapid start	.96
	1	277v		.95
	2	120v		.85
	2	277v		.96
96W F96T8	1	120 or 277v	instant start	1.10
	2			.85

\* For ballasts not specifically designed for use with dimming controls.

(4) Dimming fluorescent ballasts shall be electronic and shall comply with the applicable electronic ballast specifications shown above. Dimming ballasts shall be compatible with the specified dimming control equipment and shall operate the lamps shown in the range from full rated light output to 1 percent of full rated light output. Dimming ballasts shall provide smooth square law dimming such that perceived dimming action is proportionate to the motion of the dimming control. Single or two-lamp dimming ballasts shall be used. Multi-lamp dimming ballasts shall be designed to operate lamps of the same length and current rating.

(5) Dimming compact fluorescent ballasts shall be electronic and shall comply with the applicable compact fluorescent and dimming ballast specifications shown above. Ballasts shall operate the lamps shown in the range from full rated light output to 5 percent of full rated light output. Ballast power factor shall be <90% throughout dimming range. THD shall be <10% at maximum light output and <20% at minimum light output. Ballast shall ignite the lamps at any light output setting selected.

- c. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(1) Electronic high intensity discharge ballasts shall be constant wattage autotransformer type; shall have less than 10% ballast loss; shall have total harmonic distortion between 10 and 20%; and shall have a minimum starting temperature of 0 degrees F.

(2) Magnetic high intensity discharge ballasts shall have a

minimum starting temperature of -20 degrees F.

### 2.13.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Recessed housings shall be minimum 20 gauge cold rolled or galvanized steel as shown. Extruded aluminum fixtures shall have minimum wall thickness of 0.125 inches. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type. Conoid recessed reflector cones shall be Alzak with clear specular low iridescent finish.

- a. Incandescent fixtures shall comply with UL 1571. Incandescent fixture specular reflector cone trims shall be integral to the cone and shall be finished to match. Painted trim finishes shall be white with minimum reflectance of 88%. Low voltage incandescent fixtures shall have integral step-down transformers.
- b. Fluorescent fixtures shall comply with UL 1570. Recessed ceiling fixtures shall comply with NEMA LE 4. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Fluorescent fixture lens frames on recessed and surface mounted troffers shall be one assembly with mitered corners. Parabolic louvers shall have a low iridescent finish and 45 degree cut-off. Louver intersection joints shall be hairline type and shall conceal mounting tabs or other assembly methods. Louvers shall be free from blemishes, lines or defects which distort the visual surface. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be constructed to include grounding necessary to start the lamps. Open fixtures shall be equipped with a sleeve, wire guard, or other positive means to prevent lamps from falling. Medium bi-pin lampholders shall be twist-in type with positive locking position. Long compact fluorescent fixtures and fixtures utilizing U-bend lamps shall have clamps or secondary lampholders to support the free ends of the lamps.
- c. High intensity discharge fixture shall comply with UL 1572. Recessed ceiling fixtures shall comply with NEMA LE 4. Reflectors shall be anodized aluminum. Fixtures for horizontal lamps shall have position oriented lampholders. Lampholders shall be pulse-rated to 5,000 volts. Fixtures indicated as classified or rated for hazardous locations or special service shall be designed and independently tested for the environment in which they are installed. Recessed lens fixtures shall have extruded aluminum lens frames. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Remote ballasts shall be encased and potted. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.
- d. Emergency lighting fixtures and accessories shall be constructed and independently tested to meet the requirements of applicable

codes. Batteries shall be Nicad or equal with no required maintenance, and shall have a minimum life expectancy of five years and warranty period of three years.

e. Exit Signs

Exit signs shall be ENERGY STAR compliant, thereby meeting the following requirements. Input power shall be less than 5 watts per face. Letter size and spacing shall adhere to NFPA 101. Luminance contrast shall be greater than 0.8. Average luminance shall be greater than 15 cd/m<sup>2</sup> measured at normal (0 degree) and 45 degree viewing angles. Minimum luminance shall be greater than 8.6 cd/m<sup>2</sup> measured at normal and 45 degree viewing angles. Maximum to minimum luminance shall be less than 20:1 measured at normal and 45 degree viewing angles. The manufacturer warranty for defective parts shall be at least 5 years.

2.13.4 Lampholders, Starters, and Starter Holders

UL 542

2.14 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.14.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.14.2 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

2.14.3 Fuses, Class R

UL 198E.

2.14.4 Fuses for Supplementary Overcurrent Protection

UL 198G.

2.14.5 Fuses, D-C for Industrial Use

UL 198L.

2.14.6 Fuseholders

UL 512.

2.15 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.16 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

## 2.16.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

## 2.16.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES  
OPEN DRIP PROOF MOTORS

kW	1200 RPM	1800 RPM	3600 RPM
0.746	82.5	85.5	80.0
1.12	86.5	86.5	85.5
1.49	87.5	86.5	86.5
2.24	89.5	89.5	86.5
3.73	89.5	89.5	89.5
5.60	91.7	91.0	89.5
7.46	91.7	91.7	90.2
11.2	92.4	93.0	91.0
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	93.6
44.8	95.0	95.0	94.1
56.9	95.0	95.0	94.5
74.6	95.0	95.4	94.5
93.3	95.4	95.4	95.0
112.0	95.8	95.8	95.4
149.0	95.4	95.8	95.4
187.0	95.4	96.2	95.8
224.0	95.4	95.0	95.4
261.0	94.5	95.4	95.0
298.0	94.1	95.8	95.0
336.0	94.5	95.4	95.4
373.0	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

kW	1200 RPM	1800 RPM	3600 RPM
0.746	82.5	85.5	78.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

1.12	87.5	86.5	85.5
1.49	88.5	86.5	86.5
2.24	89.5	89.5	88.5
3.73	89.5	89.5	89.5
5.60	91.7	91.7	91.0
7.46	91.7	91.7	91.7
11.2	92.4	92.4	91.7
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	94.1
44.8	94.5	95.0	94.1
56.9	95.0	95.4	94.5
74.6	95.4	95.4	95.0
93.3	95.4	95.4	95.4
112.0	95.8	95.8	95.4
149.0	95.8	96.2	95.8
187.0	95.6	96.2	95.9
224.0	95.4	96.1	95.8
261.0	94.5	96.2	94.8
298.0	94.5	95.8	94.5
336.0	94.5	94.5	94.5
373.0	94.5	94.5	94.5

MINIMUM NOMINAL MOTOR EFFICIENCIES  
OPEN DRIP PROOF MOTORS

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

HP	TOTALLY ENCLOSED FAN-COOLED MOTORS		
	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

## 2.17 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

### 2.17.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

### 2.17.2 Motor Starters

Combination starters shall be provided with circuit breakers, or the contractor may provide combination starters in lieu of separate starter and disconnects/fusible switches.

#### 2.17.2.1 Reduced-Voltage Starters

Reduced-voltage starters shall be provided for polyphase motors 10 hp or larger unless VFDS are indicated.. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starter or part winding increment starter having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

#### 2.17.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload

protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

#### 2.17.4 Low-Voltage Motor Overload Relays

##### 2.17.4.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

##### 2.17.4.2 Construction

Manual reset type thermal relay shall be melting alloy or bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

##### 2.17.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

#### 2.17.5 Automatic Control Devices

##### 2.17.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

##### 2.17.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

##### 2.17.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked

MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.

- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

## 2.18 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

## 2.19 RECEPTACLES

All receptacles that are connected to an uninterruptible power supply (UPS) shall have a yellow color body and face. All other receptacles shall be ivory color.

### 2.19.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

### 2.19.2 Ground Fault Interrupters

UL 943, Class A or B.

### 2.19.3 Hazardous (Classified) Locations

UL 1010.

### 2.19.4 NEMA Standard Receptacle Configurations

NEMA WD 6.

#### d. 30-Ampere, 125/250 Volt

Three-pole, 3-wire, non-locking: NEMA type 10-30R, locking: NEMA type L10-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 14-30R, locking: NEMA type L14-30R.

#### e. 30-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-30R, locking: NEMA type L6-30R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-30R, locking: NEMA type L15-30R.

## 2.20 Service Entrance Equipment

UL 869A.

2.21 SPLICE, CONDUCTOR

UL 486C.

2.22 POWER-SWITCHGEAR ASSEMBLIES INCLUDING SWITCHBOARDS AND SWITCHGEAR

2.23 SNAP SWITCHES

UL 20.

2.24 TAPES

2.24.1 Plastic Tape

UL 510.

2.24.2 Rubber Tape

UL 510.

2.25 TRANSFORMERS

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below. Transformers supplying non-linear loads shall be UL listed as suitable for supplying such loads with a total K-factor not to exceed K-13 and have neutrals sized for 200 percent of rated current.

2.25.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 80 degrees C temperature rise shall be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Transformers shall be provided in NEMA 1 enclosure. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.25.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50

kVA Range	dB Sound Level
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

## 2.26 ISOLATED POWER SYSTEM EQUIPMENT

UL 1047, with monitor UL 1022.

## 2.27 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

## 2.28 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

### 2.28.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses

### 2.28.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall coordinate with the base electrical engineer for fault current availability at the site.

### 2.28.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provide, impedance data shall be shown. Locations of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

### 2.28.4 Fault Current Analysis

#### 2.28.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

#### 2.28.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be documented in the report.

#### 2.28.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

#### 2.28.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. Provide a written narrative that describes: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situation where system coordination is not achievable due to device limitations (an analysis of any device curves which order overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

#### 2.28.6 Study Report

- a. The report shall include a narrative: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device curves and protective device ratings and settings.
- d. The report shall contain fully coordinated composite time-current characteristic curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.
- e. The report shall provide the calculations performed for the

analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

## 2.29 Raised Access Floor Box

UL 514A Die cast aluminum body. The box lid shall be a hinged style and constructed of polycarbonate material. The box lid shall have a finish color of brown. The lid shall provide a minimum of three (3) removable cable guards for egress of power and communication workstation cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position. The trim flange shall be constructed of polycarbonate material and have a minimum overall dimension of 8 3/4" x 10 3/4". The hinged lid and trim flange shall be available for either carpet or tile floor applications. Coordinate the trim flange with the flooring in the location where the box is installed. The wiring chamber shall provide an upper and a lower compartment. The top compartment shall be divided into three (3) separate compartments to accommodate a combination of both power and communication wiring. These compartments shall be separated by use of integral; die cast aluminum built in dividers. The bottom compartment shall be available for either all power or all communication wiring. The total Box Volume capacity shall have a minimum of 300 cubic inches. Provide locking tabs. Activation and connectivity outlets and electrical outlets shall be as indicated on the drawings. The Raised Access Floor Box shall be as manufactured by Walker Model AF3 or approved equal.

## PART 3 EXECUTION

### 3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

#### 3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 5 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers, or if sectional type rods are used. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 5 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

#### 3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms communications rooms , server farms and as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. For raised floor equipment rooms in computer and data processing centers,

a minimum of 4, one at each corner, multiple grounding systems shall be furnished. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

### 3.1.3 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

## 3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit rigid plastic conduit (below slab only) electrical metallic tubing intermediate metal conduit. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

### 3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit may be used below slab only. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70.

Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07840A FIRESTOPPING. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be

provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

#### 3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

#### 3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

#### 3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlap, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

#### 3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

#### 3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

#### 3.2.1.6 Supports

Metallic conduits and tubing, and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

#### 3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

#### 3.2.1.8 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

#### 3.2.1.9 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter. Minimum conduit size shall be 3/4 inch

#### 3.2.2 Busway Systems

Busway systems shall be of the voltage, capacity, and phase characteristics indicated. Vertical runs of busways within 6 feet of the floor shall have solid enclosures. Busways shall be supported at intervals not exceeding 5 feet, and shall be braced properly to prevent lateral movement. Busways penetrating walls or floors shall be provided with flanges to completely close wall or floor openings.

### 3.2.3 Cable Trays

Cable trays shall be supported in accordance with the recommendations of the manufacturer but at no more than 6 foot intervals and as indicated. Contact surfaces of aluminum connections shall be coated with an antioxidant compound prior to assembly. Adjacent cable tray sections shall be bonded together by connector plates of an identical type as the cable tray sections. The Contractor shall submit the manufacturer's certification that the cable tray system meets all requirements of Article 318 of NFPA 70. The cable tray shall be installed and grounded in accordance with the provisions of Article 318 of NFPA 70. Data submitted by the Contractor shall demonstrate that the completed cable tray systems will comply with the specified requirements. Cable trays shall terminate 10 inches from both sides of smoke and fire partitions. Conductors run through smoke and fire partitions shall be installed in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of the partitions. The installation shall be sealed to preserve the smoke and fire rating of the partitions. Penetrations shall be firestopped in accordance with Section 07840A FIRESTOPPING.

### 3.2.4 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

#### 3.2.4.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

#### 3.2.4.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used.

#### 3.2.4.3 Cable Systems

Cable systems shall be installed where indicated.

#### 3.2.4.4 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.
- c. Greater Than 600 Volt: Cable splices shall be made in accordance with the cable manufacturer's recommendations and Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

#### 3.2.4.5 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:
  - 120/208-volt, 3-phase: Black(A), red(B), and blue(C).
  - 277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

### 3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors.

Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

### 3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 1 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

### 3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

### 3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be

mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

### 3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

### 3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be satin finish corrosion resistant stainless steel. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

### 3.5 RECEPTACLES

#### 3.5.1 Single and Duplex, 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of yellow for systems on UPS power and ivory for non-ups systems and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

#### 3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only

When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

#### 3.5.2.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

#### 3.5.2.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use. Assemblies which utilize a self-sealing boot or gasket to maintain wet location rating shall be furnished with a compatible plug at each receptacle location and a sign notifying the user that only plugs intended for use with the sealing boot shall be connected during wet conditions.

#### 3.5.3 Receptacles, 30-Ampere, 125/250-Volt

Receptacles, single, 30-ampere, 125/250-volt, shall be molded-plastic, three-pole, four-wire, grounding type, complete with appropriate mating cord-grip type attachment plug.

#### 3.5.4 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

### 3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere<sup>277</sup>-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

### 3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the type indicated with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance

equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

### 3.8 PANELBOARDS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

#### 3.8.1 Loadcenters

Loadcenters are not acceptable.

#### 3.8.2 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

### 3.9 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

#### 3.9.1 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK5 CC shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

#### 3.9.2 Continuous Current Ratings (600 Amperes and Smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK5 , current-limiting, time-delay with 200,000 amperes interrupting capacity.

#### 3.9.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

### 3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits and exterior communications conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground

service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

### 3.11 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

### 3.12 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

### 3.12.1 Reduced-Voltage Controllers

Reduced-voltage controllers shall be provided for polyphase motors 10 hp or larger except where VFD's are indicated. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starters or part winding increment starters having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

### 3.12.2 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

### 3.12.3 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

### 3.13 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

### 3.14 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration as indicated except isolation transformers having a one-to-one turns ratio. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shown located within 5 feet of the exterior wall shall be provided in a weatherproof enclosure. Transformers to be located within the building may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40 degrees C ambient temperature, unless otherwise indicated.

### 3.15 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

#### 3.15.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered

to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

### 3.15.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on the drawings. Illustrations shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

#### 3.15.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

#### 3.15.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

#### 3.15.2.3 Fixtures for Installation in Grid Type Ceilings

Fixtures for installation in grid type ceilings which are smaller than a full tile shall be centered in the tile. 1 by 4 foot fixtures shall be mounted along the grid rail as shown. Work above the ceiling shall be coordinated among the trades to provide the lighting layout shown. Fixtures mounted to the grid shall have trim exactly compatible with the grid. Contractor shall coordinate trims with ceiling trades prior to ordering fixtures. Metric fixtures shall be designed to fit the metric grid specified. Fixtures in continuous rows shall be coordinated between trades prior to ordering. Fixtures shall be mounted using independent supports capable of supporting the entire weight of the fixture. No fixture shall rest solely on the ceiling grid. Recessed fixtures installed in seismic areas should be installed utilizing specially designed seismic clips. Junction boxes shall be supported at four points.

#### 3.15.2.4 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers or hand-straightens so that they hang plumb. Pendants, rods, or chains 4 feet or longer

excluding fixture shall be braced to prevent swaying using three cables at 120 degrees of separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

Suspended fixtures installed in seismic areas shall have 45% swivel hangers and shall be located with no obstructions within the 45% range in all directions. The stem, canopy and fixture shall be capable of 45% swing.

### 3.15.3 Ballasts

Remote type ballasts or transformers, where indicated, shall be mounted in a well ventilated, easily accessible location, within the maximum operating distance from the lamp as designated by the manufacturer.

### 3.15.4 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

### 3.16 BATTERY CHARGERS

Battery chargers shall be installed in conformance with NFPA 70.

### 3.17 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

#### 3.17.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

#### 3.17.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

### 3.18 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

### 3.19 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTS AND COATINGS.

### 3.20 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

#### 3.20.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.20.2 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements.

Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 10 ohms.

#### 3.20.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 72 hours before the site is ready for inspection.

#### 3.20.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test

voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$R$  in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

#### 3.20.4.1 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

#### 3.20.5 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

#### 3.20.6 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers .

- a. Insulation resistance test phase-to-ground, each phase.
- b. Turns ratio test.

#### 3.20.7 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

##### 3.20.7.1 Circuit Breakers, Low Voltage

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual and electrical operation of the breaker.

##### 3.20.7.2 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

### 3.20.8 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

### 3.21 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

### 3.22 FIELD SERVICE

#### 3.22.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 72 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

#### 3.22.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.23 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

## SECTION 16442

## MAIN OUTDOOR WALKIN SWITCHGEAR

03/01

## PART 1 GENERAL

This section applies to the outdoor main walkin switchgear including the controls and auxiliaries for paralleling and backup generators.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1 (1981; R 1992) Electrical Analog Indicating Instruments

ANSI C57.12.29 (1991) Switchgear and Transformers - Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M 232

ASTM A 167 (1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 780 (2000) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM D 149 (1997; Rev. A) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code (ANSI/IEEE)

IEEE C37.13 (1990) Low-Voltage AC Power Circuit Breakers Used in Enclosures (ANSI/IEEE)

IEEE C37.20.1 (1993) Metal-Enclosed Low-Voltage Power  
Circuit Breaker Switchgear (ANSI/IEEE)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C57.12.28 (1999) Pad-Mounted Equipment - Enclosure  
Integrity (Revision of ANSI C57.12.28-88)

NEMA C12.1 (1995) Code for Electricity Metering

NEMA ICS 6 (1993) Industrial Control and Systems  
Enclosures

NEMA LI 1 (1998) Industrial Laminating Thermosetting  
Products

NEMA ST 20 (1992) Dry-Type Transformers for General  
Applications

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (1999) Electrical Power Distribution  
Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; R 1999, Bul. 2000) Grounding and  
Bonding Equipment

UL 489 (1996; R 2000, Bul. 1999 and 2000)  
Molded-Case Circuit Breakers, Molded-Case  
Switches, and Circuit-Breaker Enclosures

UL 1558 (1999, Bul. 1999) Metal-Enclosed  
Low-Voltage Power Circuit Breaker Switchgear

## 1.2 RELATED REQUIREMENTS

Section 16415, "ELECTRICAL WORK, INTERIOR," apply to this section, with the additions and modifications specified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, AE

Paralleling Control System; G, AE

SD-03 Product Data

Switchgear; G, AE

Paralleling Control System; G, AE

Paralleling Control System software and Programming; G, AE

SD-06 Test Reports

Switchgear design tests; G, AE

Switchgear production tests; G, AE

Acceptance checks and tests; G

Paralleling Operational Test; G, AE

SD-10 Operation and Maintenance Data

Switchgear Operation and Maintenance, Data Package 5; G, AE

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals;

Equipment Test Schedule; G, AE

Request for Settings; G

Paralleling Operational Performance; G, AE

1.4 QUALITY ASSURANCE

1.4.1 Switchgear Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchgear including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings
- b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

1.4.2 Switchgear Drawings

Drawings shall include, but are not limited to the following:

- a. One-line diagram including breakers, current transformers, and meters
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions

- c. Bus configuration including dimensions and ampere ratings of bus bars
- d. Markings and NEMA nameplate data
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings
- f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.
- h. Provisions for future extension.

## 1.5 MAINTENANCE

### 1.5.1 Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01781, "Operation and Maintenance Data."

### 1.5.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and binded securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

- a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".
- b. Catalog data required by the paragraph entitled, "SD-03, Product Data".
- c. Drawing required by the paragraph entitled, "SD-02, Shop Drawings".
- d. Prices for spare parts and supply list.
- e. Information on metering
- f. Design test reports
- g. Production test reports

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be switchgear and related accessories are specified in Section 16415, "ELECTRICAL WORK, INTERIOR,".

## 2.2 SWITCHGEAR

IEEE C37.20.1 and UL 1558.

### 2.2.1 Ratings

The voltage rating of the switchgear shall be 480Y/277 volts AC, 4-wire 3. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be rms symmetrical amperes as indicated. The switchgear shall be UL listed and labeled as service entrance equipment.

### 2.2.2 Construction

Switchgear shall consist of vertical sections bolted together to form a rigid assembly and shall be rear aligned. All circuit breakers shall be front accessible. Rear aligned switchboards shall have front accessible load connections. Compartmentalized switchgear shall have vertical insulating barriers between the front device section, the main bus section, and the cable compartment with full front to rear vertical insulating barriers between adjacent sections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

#### 2.2.2.1 Enclosure

The switchgear enclosure shall be a outdoor NEMA ICS 6 Type 3R walk-in protected-aisle fabricated entirely of 11 gauge, minimum, galvanized steel or ASTM A 167 type 304 or 304L stainless steel. Enclosure shall be welded together with side end doors, and sloping roof downward toward rear. Side doors shall be provided with pad vault handles with a three point catch. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A 167 type 304 or 304L stainless steel. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication where practicable. Paint enclosure "Langley Brown. Paint coating system shall comply with NEMA C57.12.28 for galvanized steel and ANSI C57.12.29 for stainless steel. Enclosure and switchgear shall be vented according to the manufacturer's standard practice.

#### 2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchgear. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear. The neutral bus shall be rated 100 percent of the main bus continuous current rating. Phase bus bars shall be insulated with an epoxy finish coating powder providing a minimum breakdown voltage of 16,000 volts per ASTM D 149.

#### 2.2.2.3 Main, Tie, Building Feeder and Generator Feeder Sections

Shall consist of an individually mounted drawout air power circuit breaker .

#### 2.2.2.4 Distribution Sections

The distribution section(s) shall consist of molded-case circuit breakers.

#### 2.2.2.5 Auxiliary Sections

Auxiliary sections shall consist of indicated instruments, metering equipment, control equipment, transformer, paralleling controls, and current transformer compartments.

#### 2.2.2.6 Handles

Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

#### 2.2.3 Protective Device

Provide protective devices as specified herein and as indicated.

##### 2.2.3.1 Power Circuit Breaker (Main, Tie, Building Feeder and Generator Feeders)

IEEE C37.13. 120 Vac electrically operated drawout, unfused, low-voltage power circuit breaker with a short-circuit current rating of rms amperes symmetrical as indicated at rated volts. Breaker frame size shall be as indicated. Equip electrically operated breakers with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.

##### 2.2.3.2 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 100 percent rated, stationary, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of rms symmetrical amperes as indicated at rated volts. Breaker frame size shall be as indicated. Series rated circuit breakers are unacceptable.

#### 2.2.4 Drawout Breakers

Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. The main, auxiliary, and control disconnecting contacts shall be silver-plated, multifinger, positive pressure, self-aligning type. Each drawout breaker shall be provided with four-position operation. Each position shall be clearly identified by an indicator on the circuit breaker front panel.

- (1) Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.
- (2) Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. Position shall allow complete test and operation of the breaker without energizing the primary circuit.
- (3) Disconnected Position: Primary and secondary contacts are

disconnected.

- (4) Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker shall actuate assembly that isolates the primary stabs.

#### 2.2.5 Electronic Trip Units

Equip breakers 600 amperes and above with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be the same as the breaker frame rating. The trip unit ampere rating shall be as indicated. Ground fault protection shall be zero sequence sensing or residual type sensing. The electronic trip units shall have the following features.

- a. Breakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.
- b. Breakers shall have short delay pick-up and time settings and, instantaneous settings and ground fault settings.
- d. Main and Building Feeder Breakers shall have a digital display for phase and ground current.
- e. Main and Building Feeder Breakers shall have a digital display for watts, vars, VA, kWh, kvarh, and kVAh.
- f. Main and Building Feeder Breakers shall have a digital display for phase voltage, and percent THD voltage and current.

#### 2.2.6 Instruments

ANSI C39.1 for electrical indicating switchboard instruments, with 2 percent accuracy. Provide digital type metering. Provide current transformers and voltage transformers as required.

#### 2.2.7 Meter Fusing

Provide metering fusing as required. Size fuses as recommended by the meter manufacturer.

#### 2.2.8 Heaters

Provide 120-volt heaters in each switchgear section. Heaters shall be of sufficient capacity to control moisture condensation in the section, shall be 250 watts minimum, and shall be controlled by a thermostat and humidistat located in the section. Thermostat shall be industrial type, high limit, to maintain sections within the range of 60 to 90 degrees F. Humidistat shall have a range of 30 to 60 percent relative humidity. Supply voltage for the heaters shall be obtained from a control power transformer. If heater voltage is different than switchboard voltage, provide transformer rated to carry 125 percent of heater full load rating. Transformer shall have 220 degrees C insulation system with a temperature rise not exceeding 115 degrees C and shall conform to NEMA ST 20. Energize electric heaters in switchboard assemblies while the equipment is in storage or in place prior to being placed in service. Provide method for easy connection of

heater to external power source. Provide temporary, reliable external power source if commercial power at rated voltage is not available on site.

#### 2.2.9 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers shall be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

#### 2.2.10 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

#### 2.3 Enclosure auxiliaries and distribution

Provide the following in the walkin enclosure: four 2 lamp fluorescent damp label light fixtures, light switch at each end of the walkin enclosure, four duplex convenience outlets, dry type transformer as indicated, panelboard as indicated, conduit wire and all required accessories for a complete installation.

#### 2.4 NAMEPLATES

Provide as specified in division 16.

#### 2.5 WARNING SIGNS

Provide as specified in division 16

#### 2.6 SOURCE QUALITY CONTROL

##### 2.6.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

##### a. Test Instrument Calibration

(1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

- (2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.
- (3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels shall be visible on all test equipment.
- (5) Calibrating standard shall be of higher accuracy than that of the instrument tested.
- (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
  - (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

#### 2.6.2 Switchgear Design Tests

IEEE C37.20.1 and UL 1558.

##### 2.6.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

- a. Short-circuit current test
- b. Enclosure tests
- c. Dielectric test

##### 2.6.2.2 Additional design tests

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

- a. Temperature rise tests
- b. Continuous current

#### 2.6.3 Switchgear Production Tests

IEEE C37.20.1 and UL 1558. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

- a. 60-hertz dielectric tests
- b. Mechanical operation tests

- c. Electrical operation and control wiring tests
- d. Ground fault sensing equipment test

## 2.7 Paralleling Control System

Provide complete assembled paralleling equipment with digital electronic controls designed for fast, reliable operation and including the functions described herein. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001. Provide all required current transformers, voltage transformers, transducers, software, touchscreens, and appertenances for a complete operational system.

### 2.7.1 System Control Power

Control power for the paralleling system shall be derived from the generator set 24VDC starting batteries. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. Generator set governing, voltage regulation, load sharing, synchronizing, protection, and control equipment shall be capable of proper operation with battery voltage levels down to 8VDC.

#### 2.7.1.1 Control Power

Control power for the paralleling system shall be derived from the generator set 24VDC starting batteries. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. Generator set governing, voltage regulation, load sharing, synchronizing, protection, and control equipment shall be capable of proper operation with battery voltage levels down to 8VDC.

#### 2.7.1.2 Redundant Power

A redundant 24VDC control power supply shall be provided for the system master control, including batteries, rack, and charger.

#### 2.7.1.3 Paralleling Breaker Control Power

Paralleling breaker control power shall be derived from the generator set for charging, opening, and closing the breakers.

### 2.7.2 Paralleling Controls

Provide a paralleling control panel for each generator set. The paralleling control functions may be integrated with the generator set control functions (with duplicate functions eliminated). Each paralleling control panel shall contain the components and devices as described in this section.

#### 2.7.2.1 Operator Panel

Each paralleling control panel shall be provided with a panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the

following features and capabilities.

- a) 1% accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter. Selector switches to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Voltmeter and frequency meter shall be analog instruments. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.
- b) Synchroscope and "generator set synchronized" indication. Indication may be synchronizing lamps, LED indication, or other provisions, but must be located on the paralleling control panel, adjacent to the paralleling breaker control switches.
- c) Running Time Meter, Start Counter
- d) Generator Set Mode Selector Switch: Switch shall provide run, off, and automatic functions for control of the generator set. Run mode causes the generator set to immediately start and accelerate to rated speed and voltage, but paralleling breaker does not automatically close. Off mode prevents generator set from starting, or immediately shuts down the generator set if it is running. Auto mode allows genset starting from a remote control system.
- e) Breaker trip/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.
- f) Control Reset push button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
- g) Lamp test push button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.
- h) The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.
- i) Emergency Stop switch. The emergency stop switch shall be a red, mushroom head switch which maintains its position until manually reset.
- j) Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustment switches shall be located adjacent to the generator set and bus metering, breaker control switches, synchroscope and manual paralleling panel, for ease of use by the operator.
- k) Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control) :

#### Alarm and status indicating panel

Function	Lamp Color	Alarm Horn	Shutdown Unit
Low DC Voltage	Amber	*	
High DC Voltage	Amber	*	
Weak Battery	Amber	*	
Fail to Sync	Amber	*	
Low Oil Pressure Alarm	Amber	*	
Low Fuel - daytank	Amber	*	
High Engine Temp Alarm	Amber	*	
Ground Fault	Amber	*	
Overcurrent Alarm	Amber	*	
Breaker Failure	Red	*	*
Breaker Tripped	Red	*	*
Not in Auto	Red	*	*
High Engine Temp	Red	*	*
Low Oil Pressure	Red	*	*

Alarm and status indicating panel			
Overcurrent	Red	*	*
Short Circuit	Red	*	*
Loss of Excitation	Red	*	*
Reverse Power	Red	*	*
Overcrank	Red	*	*
Overspeed	Red	*	*
Under Frequency	Red	*	
Under Voltage	Red	*	*
Over Voltage	Red	*	*
Phase Rotation	Red	*	*
Low Coolant Level	Red	*	*
Automatic	Green		
Generator Running	Green		
Breaker Open	Green		
Breaker Closed	Green		
Demand Mode Standby	Green		
Timing for Start	Green		
Timing for Shutdown	Green		

#### 2.7.2.2 Internal Controls

The following internal control components or functions shall be provided for each generator set in the system.

- a) Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an infinite bus. The infinite bus governing controls shall allow the generator set to synchronize to an infinite bus, parallel, and ramp up to a preset load level on the generator set. Additional controls shall be provided to cause the generator set to ramp up to a kW load level signaled by the system master control PLC. The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.
- b) Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to it's proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.
- c) Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)
- d) Equipment shall be provided to monitor the generator set as it is starting, and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out of phase paralleling if two or more engine generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls

to recognize the failure of the first breaker signaled to close, and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out of phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.

e) Synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine generator voltage within 1% of bus voltage and phase angle within 20 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120 seconds. Control logic for fail to synchronize function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition.

f) Controls shall include a permissive relay function to assure that the generator set does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.

g) Controls shall include a permissive (sync check) function, to be used with "generator synchronized" indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.

h) Control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.

i) Controls shall include three phase sensing reverse power equipment, to prevent sustained reverse power flow into the generator set. When the reverse power condition exceeds 10% of the generator set kW for 3 seconds, the paralleling circuit breaker shall be tripped open and the generator shut down.

j) Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.

k) Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.

l) Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function.

m) Provide overcurrent and short circuit protection for the feeder connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.

n) Controls shall be provided to sense loss of excitation of the alternator while paralleled to the system bus.

o) Generator set start contacts rated 10 amps at 32 VDC. A redundant network-based starting system shall also be provided.

p) Cooldown time delay, adjustable: 0-600 seconds. The control panel

shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.

q) Start time delay, adjustable: 0-300 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for start.

r) The control system shall monitor the paralleling breaker auxiliary contacts, and initiate a fault signal if the breaker fails to close within an adjustable time delay period after the control has signaled it to close (0.5-15 seconds). Breaker failure alarm shall cause the paralleling breaker to trip open, and lock out until manually reset.

s) Controls shall be provided to initiate an alarm condition when generator set is at 90% of rated frequency for more than 20 seconds.

t) Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 15 seconds, more than 110% of nominal voltage for more than 10 seconds, or more than 130% of nominal.

u) Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for a complete operable system.

### 2.7.3 Master Control System

Provide a system master control to monitor and control the operation of the entire paralleling system, including the generator set controls. The master control panel shall contain the components and functions described in this section.

#### 2.7.3.1 Solid State System Status Panel

Solid State System Status Panel. A system status panel shall be provided and shall include the following features and functions:

#### Solid State System Status Panel

- " Alarm Silence Push-button Switch
- " Alarm horn
- " LED Indicating lamps to indicate the following conditions:

Function	Color	Alarm Horn
Generator Set #n On Line. (one for each genset in the system)	Green	
Load Demand Mode	Green	
Priority #n Load On (one for each load add level in the system)	Green	
Load Shed Level n (one for each load shed level in the system)	Red	*
System Test	Green	
Remote System Start	Amber	
Check Generator Set #n (one for each genset in the system)	Red	*
Controller Malfunction	Red	*
Check Station Battery	Red	*
Bus Overload	Red	*
System Not in Auto Mode	Red	*

#### 2.7.3.2 Operator Interface Panel (OIP)

A full color high resolution OIP type operator interface panel (OIP) shall be provided which allows the operator to monitor and control the on site power system. The OIP shall have a minimum viewing area of 100 square inches. The components shown on the OIP shall all be designated as shown on the drawings. All data shall be configurable for display in either US standard or metric indications. The OIP shall include the following screens and/or functions:

a) Screens shall be configured in a typical Windows<sup>TM</sup> format, with a pop-up menu in the lower left corner of the screen providing access to various screens. There shall not be a close program "button" in the upper right corner of any screen. (Closing the program shall be accomplished only through the menu structure.) There shall be a context sensitive help button on each screen.

b) One Line Diagram Screen. The one-line diagram screen shall display a system message (to advise the operator of needed or optional control operations), and shall also show the system status by a combination of animation, changing screen color, text messages, and pop-up indicators. Conditions visible on the screen shall include:

" Generator set(s), and bus configuration, with generator set, parallel breaker and bus energized/de-energized indication (red indicating energized, green indicating de-energized).

" Generator set designation. Control, data, and performance summary screens shall be accessible through hot keys (links) located on or adjacent to the genset icon.

" Generator set mode (run/off/auto)

" Generator set status (normal/warning/shutdown/load demand stop/% load). Pop-up screens shall provide access to detailed information and service manuals from the one-line diagram screen.

" Paralleling breaker status (open/closed/tripped)

" Bus condition (energized or de-energized)

" Access to other system control and monitoring functions through a menu button with pop-up option display

" Help "button" to allow access to information concerning the specific screen viewed, or concerning current system status.

c) System Control. The system control screen shall provide the operator with the ability to enable or disable load demand operation; initiate test (with or without load); control the shutdown sequence for the generator sets in the load demand mode; set the load demand time delays; set the load demand operation set points; and display and modify the automatic load add and shed sequence.

d) Genset Control. The genset control screen shall be a popup control screen to allow the operator to manually start and stop the genset, and manually open and close the genset paralleling breaker. It shall also display generator set status and percent load.

e) Genset Data Display. The genset data display shall provide the operator with information on the status and condition on the generator set.

It shall include all data displayed at the local generator set control panel, and as a minimum shall include: engine rpm, oil pressure, coolant temperature, DC voltage, engine hours, genset MW hours, number of starts, line to line and line to neutral voltage on all phases, bus line to line and line to neutral voltage on all phases, genset and bus frequency, load current, power factor, kVAR and kw, local control switch status, and genset status. It shall also provide display of all active faults in the local generator set control. The screen shall include a strip chart function that allows the operator to add any monitored data point to a scrolling screen to develop an active graphical display of conditions on that generator set.

f) Genset Status Summary. The genset status summary shall provide an

analog and graphical display of critical generator set operating parameters. The screen shall include generator set state display (stopped, time delay start, idle speed state, rated volts/hz, synchronizing, load share, or load govern); analog AC metering for generator set, including 3-phase AC volts and current, frequency, kW, and power factor; and 3-phase AC bus voltage and frequency. The screen shall also include a strip chart function that allows the operator to add any function or value on to the strip chart to provide an active display of the condition of the system.

g) Load Control. The load control screen shall provide an analog display of system load as a percent of available capacity of the generator sets that are operating in parallel on the bus. The screen shall also provide an alphanumeric display of this data. It shall also display the name, status and priority of each load block (whether on or off), and the total load of that block. The screen shall allow the operator to manually add and shed loads in any sequence desired.

h) Trending. The Touchscreen shall be capable of providing real time trend charts for any monitored value in the system, with up to 8 monitored points at any time. Historical trend charts using a data log function in the control shall also be provided. Historical charts shall be configurable for functions displayed, and for the time frame displayed, and shall allow comparison of historical data from multiple time periods simultaneously.

i) Alarms. Any alarm on any generator set or in the system shall result in a pop-up screen display that describes the equipment where the fault has occurred, and the name of the fault. The screen shall allow the operator to attempt to reset the fault from the OIP. It shall also offer direct access to manuals.

j) Service Information. The service information pop-up screen shall include the name, address, and phone number for the local service point for the equipment.

k) Service Manuals. The OIP shall include the ability to display the entire content of all operating and service manuals for the entire system, including generator sets (engine, alternator and control system), paralleling controls, master controls, and transfer control equipment. This requirement is in addition to the hard copy manuals required elsewhere in this specification.

l) Transfer Controls. A transfer control screen shall be provided for each transfer breaker pair in the system. The transfer control screens shall provide status information on the condition of the normal service and generator service at each device (service available), which source is connected to the load, as well as transfer control status. Information to be provided shall include:

" Indication "lamps" for common alarm, not in auto, test/exercise mode, load shed, transfer inhibit, retransfer inhibit, fail to close, fail to disconnect

" AC data at the transfer pair, including line to line and line to neutral AC Volts for all phases of both sources, frequency of both sources, load current, power factor, kW, and kVA for the load.

" Test "pushbutton" and fault reset "pushbutton".

" The screen shall also display status of all active time delays and all active faults.

### 2.7.3.3 Internal Control Components

The following internal controls shall be provided within the master control section:

a) Programmable controller (PLC or PC) for interface with OIP, and to provide load demand, load pick up, and load shed functions. Documentation

provided with the equipment shall include PLC program documentation.

b) Load pick up output contacts, rated 10 A at 600 VAC (3 contacts per level). Provide direct control for all feeder breakers in the system (14 total).

c) Load shed output contacts, rated 10 A at 600 VAC (3 contacts per level). Provide direct control for all feeder breakers in the system (14 total).

d) Digital Transducer(s), PT's, and CT's and other equipment required to provide bus condition information to the PLC.

#### 2.7.3.4 Other Components

Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for proper and reliable system operation.

#### 2.7.4 PARALLELING OPERATION

##### 2.7.4.1 Loss Of Normal Power

A. System is given signal to start by receipt of start signal from the power transfer control(s) (Master PC or PLC) or other remote device. On receipt of this signal, all generator sets automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first start system monitors this process, and on finding a generator set at 90% of rated voltage and frequency, automatically disables all other units from closing to the bus, and closes the ready unit to the bus. At this time the utility main breakers are opened, non-essential loads are shed, and the generator main bus breakers connect generator sets to the system bus.

B. The priority (load add) controls prevent overloading of the system bus by providing control signals to delay operation of designated system loads until sufficient generating capacity is available on the bus, or until the priority override switch on the OIP is actuated.

C. After the first unit is closed to the bus, the control of the remaining units is switched to the synchronizer in each generator paralleling control, which causes the generator set to synchronize with the system bus, and then close to it at the proper time.

D. As each unit closes to the bus, the unit assumes it's proportional share of the total load on the bus, and the control system will automatically add loads to the generator bus by closing feeder breakers.

##### 2.7.4.2 Failure Of A Unit To Start Or Synchronize:

A. If a unit fails to start, after the overcrank time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound. The priority control will prevent the lowest priority loads from being added to the system without manual intervention. The priority override controls on the OIP may be used by an operator to manually add low priority loads to the bus, if he determines that generator capacity is available to serve the loads. Bus overload monitoring shall protect the first priority loads in the event that the bus is inadvertently overloaded due to operator error.

B. If a unit fails to synchronize, after a preset time delay, an alarm will sound, but the unit will continue to attempt to synchronize until signalled to stop by manual operation of the control switches on the generator set.

#### 2.7.4.3 Bus Overload

- A. If a bus overload occurs for any reason, a load shed signal will be generated to initiate load shedding in the system.
- B. If the bus does not return to proper frequency within a predetermined period of time (adjustable via the OIP), additional load shed signals will be generated until the generator set bus returns to normal frequency.
- C. Loads that are shed due to overload shall require manual reset via the OIP.

#### 2.7.4.4 Load Demand Mode

- A. When the system running in the emergency mode with the "load demand" switch on the OIP in the "on" position, controls shall continuously monitor the total load on the bus. If the total load on the bus falls below preset limits for a period of 15 minutes, the controller will automatically shut down generator sets in an operator predetermined order, until the minimum number of generators required to operate the load remain on the bus. The purpose of this function is to allow the generator sets to operate closer to their rated capacity, thereby decreasing fuel consumption, and reducing wear on the system.
- B. On sensing that the available bus capacity is being approached, the standby units will automatically be restarted (in the reverse order of which they were shut down) and paralleled with the bus to assume their proportional share of system load.

#### 2.7.4.5 Return of Normal Power

- A. When all of the system start signals are removed from the generator sets, the system will begin a retransfer process in either an open or closed transition mode, as selected by the operator.
- B. If running in the closed transition mode, the system shall synchronize the generator bus to the first utility source, close the utility breaker, ramp down load on the generator breaker to a minimum value, then open the generator bus breaker. This process shall be repeated sequentially across each breaker transfer pair.
- C. If running in the open transition mode, the system shall sequentially transfer back to the utility by opening each generator bus breaker, then closing it's associated utility breaker at an operator-programmed time period later. This process shall be repeated sequentially across each breaker transfer pair.
- D. When all loads have been transferred back to the utility, the generator set paralleling breakers shall all open, and the generator sets shall operate at no load for a cooldown period. When the cooldown period has been completed, the generator sets shall shut down.
- E. If a system start signal is received during the cooldown period, one generator set shall immediately close to the system bus and all other units shall synchronize to it, as described in "Loss of Normal Power" above.
- F. Test With Load Mode:
  - 1. The system shall allow the generator sets to be tested by transfer of the system loads to the generator sets. Systems loads shall transfer in either an open or closed transition mode, as determined by the setup of the control system for emergency standby operation.
  - 2. Sequence of operation in this mode shall be similar to that described for a power failure condition.
  - 3. When the system is operating in the closed transition mode, it shall always transfer between "good" sources without a power interruption to the load.

#### G. Generator Set Exercise (Test) Without Load Mode

1. The system shall allow testing of the generator sets at no load. In this operation mode the generator sets will start, build up to rated speed and voltage, synchronize and close to the generator bus, but system loads shall not automatically transfer to the generator system.

### 2.7.5 OTHER REQUIREMENTS

Factory Testing. The system manufacturer shall perform a complete operational test on the paralleling system (including generator sets, paralleling controls, and power switchgear) prior to shipping from the factory. A certified test report shall be provided, and permanently retained by the system manufacturer.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

#### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 16375, "Electrical Distribution System, Underground". Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

#### 3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 30 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

#### 3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 16375, "Electrical Distribution System, Underground".

#### 3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

### 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

#### 3.3.1 Switchgear

IEEE C37.20.1.

### 3.3.2 Meters and Instrument Transformers

NEMA C12.1.

### 3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

## 3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

### 3.4.1 Exterior Location

Mount switchgear on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03300, "Cast-In-Place Concrete".

## 3.5 FIELD QUALITY CONTROL

Contractor shall submit settings of breakers to the Contracting Officer for approval and at least 30 days in advance of their requirement.

### 3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

#### 3.5.1.1 Switchgear

##### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

- (6) Verify that circuit breaker sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchgear.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier installation.
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that vents are clear.
- (16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform overpotential tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.
- (6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.
- (7) Verify operation of switchgear heaters.

3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.

- (2) Inspect physical and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
- (5) Verify that all maintenance devices are available for servicing and operating the breaker.
- (6) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- (7) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Verify cell fit and element alignment.
- (10) Verify racking mechanism.

b. Electrical Tests

- (1) Perform contact-resistance tests on each breaker.
- (2) Perform insulation-resistance tests.
- (3) Adjust Breaker(s) for final settings in accordance with Government provided settings.
- (4) Determine long-time minimum pickup current by primary current injection.
- (5) Determine long-time delay by primary current injection.
- (6) Determine short-time pickup and delay by primary current injection.
- (7) Determine ground-fault pickup and delay by primary current injection.
- (8) Determine instantaneous pickup value by primary current injection.
- (9) Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to ensure operation of shunt trip devices; Check the operation of electrically-operated breakers in their cubicle.
- (10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

- (11) Verify operation of charging mechanism.

### 3.5.1.3 Circuit Breakers

#### Low Voltage Molded Case with Solid State Trips

##### a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.
- (5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.
- (6) Inspect mechanism contacts and arc chutes in unsealed units.

##### b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Perform insulation-resistance tests.
- (3) Perform Breaker adjustments for final settings in accordance with Government provided settings.
- (4) Perform long-time delay time-current characteristic tests
- (5) Determine short-time pickup and delay by primary current injection.
- (6) Determine ground-fault pickup and time delay by primary current injection.
- (7) Determine instantaneous pickup current by primary injection.
- (8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

### 3.5.1.4 Current Transformers

##### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

3.5.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watt-hour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.6 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any

wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

### 3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

## SECTION 16443

## INDOOR MAIN SWITCHBOARD

03/01

## PART 1 GENERAL

This section applies to the indoor main switchboard for electrical service.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M 232
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1535	(1997) Specifying Color by the Munsell System

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code (ANSI/IEEE)
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## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C57.12.28	(1999) Pad-Mounted Equipment - Enclosure Integrity (Revision of ANSI C57.12.28-88)
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LI 1	(1998) Industrial Laminating Thermosetting Products
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA PB 2.1	(1996) Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

## INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(1999) Electrical Power Distribution Equipment and Systems
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 467	(1993; R 1999, Bul. 2000) Grounding and Bonding Equipment
UL 489	(1996; R 2000, Bul. 1999 and 2000) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 891	(1998, Bul. 1999) Dead-Front Switchboards

## 1.2 RELATED REQUIREMENTS

Section 16415, "ELECTRICAL WORK, INTERIOR."

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Switchboard Drawings; G, AE.

### SD-03 Product Data

Switchboard; G, AE.

### SD-06 Test Reports

Switchboard design tests; G, AE.

Switchboard production tests; G, AE.

Acceptance checks and tests; G.

### SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G, AE.

### SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, AE.

Equipment Test Schedule; G, AE.

## 1.4 QUALITY ASSURANCE

#### 1.4.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings
- b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

#### 1.4.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

- a. One-line diagram including breakers, current transformers, and meters
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions
- c. Bus configuration including dimensions and ampere ratings of bus bars
- d. Markings and NEMA nameplate data
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings
- f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.
- h. Provisions for future extension.

### 1.5 MAINTENANCE

#### 1.5.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01781, "Operation and Maintenance Data."

#### 1.5.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and binded securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

- a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".

- b. Catalog data required by the paragraph entitled, "SD-03, Product Data".
- c. Drawing required by the paragraph entitled, "SD-02, Shop Drawings".
- d. Prices for spare parts and supply list.
- e. Information on metering
- f. Design test reports
- g. Production test reports

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

### 2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

#### 2.2.1 Ratings

The voltage rating of the switchboard shall be 480Y/277 or 208Y/120 volts AC, 4-wire 3 phase, as indicated. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be rms symmetrical amperes as indicated. The switchboard shall be UL listed and labeled for its intended use.

#### 2.2.2 Construction

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be rear aligned. All circuit breakers shall be front accessible. Rear aligned switchboards shall have front accessible load connections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

##### 2.2.2.1 Enclosure

The switchboard enclosure shall be a NEMA ICS 6 Type 12 . Enclosure shall be bolted together with removable bolt-on side and rear covers. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within 3 inches of concrete pad/flooring. Galvanized steel shall be ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication where practicable. Paint enclosure, including bases, ASTM D 1535 light gray No. 61 or No. 49. Paint coating system shall comply with NEMA C57.12.28 for galvanized steel.

##### 2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints

with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 200 percent of the main bus continuous current rating .

#### 2.2.2.3 Main Section

The main section shall consist of insulated-case circuit breaker with solid state electronic trip unit. The solid state electronic trip unit shall include adjustments for long time, short time, instantaneous and ground fault, including I2t for each and as specified herein..

#### 2.2.2.4 Distribution Sections

The distribution section(s) shall consist of molded-case circuit breakers as indicated. Provide breakers 600 ampere and above with solid state electronic trip unit. The solid state electronic trip unit shall include adjustments for long time, short time, instantaneous and ground fault, including I2t for each and as specified herein.

#### 2.2.3 Protective Device

Provide main and branch protective devices as indicated.

##### 2.2.3.1 Insulated-Case Breaker

UL listed, 100 percent rated, stationary, 120 Vac, electrically operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated at indicated volts. Breaker frame size shall be as indicated. Equip electrically operated breaker with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.

##### 2.2.3.2 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 80 percent rated, stationary, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of rms symmetrical amperes as indicated. Breaker frame size shall be as indicated. Series rated circuit breakers are unacceptable.

#### 2.2.4 Electronic Trip Units

Equip main and distribution breakers 600 ampere and above, with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be the same as the breaker frame rating. The trip unit ampere rating shall be as indicated. Ground fault protection shall be zero sequence sensing or residual type sensing. The electronic trip units shall have the following features and as indicated.

- a. Breakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.
- b. Breakers shall have short delay pick-up and time settings and, instantaneous settings and ground fault settings.

- c. Distribution breakers, 600 ampere and above, shall have long delay pick-up and time settings, short delay pick-up and time settings, instantaneous settings, and ground fault settings.
- d. Main Breakers shall have a digital display for phase and ground current.
- e. Main Breakers shall have a digital display for watts, vars, VA, kWh, kvarh, and kVAh.
- f. Main Breakers shall have a digital display for phase voltage, and percent THD voltage and current.

#### 2.2.5 Instruments

Provide current transformers and voltage transformers where required for metering specified herein. Provide 2% minimum accuracy current transformers and voltage transformers when provided.

##### 2.2.5.1 [Enter Appropriate Subpart Title Here] 2.3 NAMEPLATES

Provide phenolic type white on black for each protective device.

#### 2.4 SOURCE QUALITY CONTROL

##### 2.4.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

##### a. Test Instrument Calibration

- (1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- (2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.
- (3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels shall be visible on all test equipment.
- (5) Calibrating standard shall be of higher accuracy than that of the instrument tested.
- (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (a) Maintain up-to-date instrument calibration instructions

and procedures for each test instrument.

- (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

#### 3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

##### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 16375. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

##### 3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the exterior perimeter ground ring.

##### 3.2.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

#### 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

##### 3.3.1 Switchboard

NEMA PB 2.1.

##### 3.3.2 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

#### 3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

##### 3.4.1 Interior Location

Floor or substructure mount switchboard. Provide a t 4 inches thick housekeeping concrete pad for switchboards mounted on structural slab flooring. Provide a 1/2 inch chamfer for housekeeping concrete pads. The housekeeping pad shall be of adequate size to project at least 8 inches beyond the equipment. Where switchboard is mounted in an area that has raised access flooring, provide substructure steel supports for the switchboard independent of the raised access flooring. Substructure support

for switchboards shall be independent of the raised access flooring and shall be of sufficient height to make the bottom of the switchboard flush with the top of the raised access flooring..

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

##### 3.5.1.1 Switchboard Assemblies

###### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that circuit breaker sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchboard.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier installation .
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that vents are clear.
- (16) Test operation, alignment, and penetration of instrument

transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

(6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.5.1.2 Circuit Breakers

Insulated-Case and Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect circuit breaker for correct mounting.

(3) Operate circuit breaker to ensure smooth operation.

(4) Inspect case for cracks or other defects.

(5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform Breaker adjustments for final settings in accordance with Government provided settings.

(4) Perform long-time delay time-current characteristic tests

(5) Determine short-time pickup and delay by primary current injection.

(6) Determine ground-fault pickup and time delay by primary current injection.

(7) Determine instantaneous pickup current by primary injection.

(8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

### 3.5.1.3 Grounding System

#### a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

#### b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

### 3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

## SECTION 16444

## SWITCHBOARDS

03/01

## PART 1 GENERAL

This section applies to all interior switchboards except the indoor main switchboard.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M 232
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1535	(1997) Specifying Color by the Munsell System

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code (ANSI/IEEE)
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## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C57.12.28	(1999) Pad-Mounted Equipment - Enclosure Integrity (Revision of ANSI C57.12.28-88)
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LI 1	(1998) Industrial Laminating Thermosetting Products
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA PB 2.1	(1996) Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

## INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (1999) Electrical Power Distribution  
Equipment and Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 467 (1993; R 1999, Bul. 2000) Grounding and  
Bonding Equipment

UL 489 (1996; R 2000, Bul. 1999 and 2000)  
Molded-Case Circuit Breakers, Molded-Case  
Switches, and Circuit-Breaker Enclosures

UL 891 (1998, Bul. 1999) Dead-Front Switchboards

## 1.2 RELATED REQUIREMENTS

Section 16415, "ELECTRICAL WORK, INTERIOR."

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Switchboard Drawings; G, AE.

## SD-03 Product Data

Switchboard; G, AE.

## SD-06 Test Reports

Acceptance checks and tests; G.

## SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G, AE.

## SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, AE.

Equipment Test Schedule; G, AE.

## 1.4 QUALITY ASSURANCE

## 1.4.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component,

device and accessory provided with the switchboard including:

- a. Circuit breaker type, interrupting rating, and trip devices, including available settings
- b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

#### 1.4.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

- a. One-line diagram including breakers, current transformers, and meters
- b. Outline drawings including front elevation, section views, footprint, and overall dimensions
- c. Bus configuration including dimensions and ampere ratings of bus bars
- d. Markings and NEMA nameplate data
- e. Circuit breaker type, interrupting rating, and trip devices, including available settings
- f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.
- g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.
- h. Provisions for future extension.

### 1.5 MAINTENANCE

#### 1.5.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01781, "Operation and Maintenance Data."

#### 1.5.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and binded securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

- a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".
- b. Catalog data required by the paragraph entitled, "SD-03, Product Data".

- c. Drawing required by the paragraph entitled, "SD-02, Shop Drawings".
- d. Prices for spare parts and supply list.
- e. Information on metering
- f. Design test reports
- g. Production test reports

## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

### 2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

#### 2.2.1 Ratings

The voltage rating of the switchboard shall be 480Y/277 or 208Y/120 volts AC, 4-wire 3 phase, as indicated. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be rms symmetrical amperes as indicated. The switchboard shall be UL listed and labeled for its intended use.

#### 2.2.2 Construction

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be rear aligned. All circuit breakers shall be front accessible. Rear aligned switchboards shall have front accessible load connections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

##### 2.2.2.1 Enclosure

The switchboard enclosure shall be a NEMA ICS 6 Type 12 . Enclosure shall be bolted together with removable bolt-on side and rear covers. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within 3 inches of concrete pad/flooring. Galvanized steel shall be ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication where practicable. Paint enclosure, including bases, ASTM D 1535 light gray No. 61 or No. 49. Paint coating system shall comply with NEMA C57.12.28 for galvanized steel.

##### 2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section

along the entire length of the switchboard. The neutral bus shall be rated 200 percent of the main bus continuous current rating .

#### 2.2.2.3 Main Section

The main section shall consist of insulated-case circuit breaker with solid state electronic trip unit. The solid state electronic trip unit shall include adjustments for long time, short time, instantaneous and ground fault, including I2t for each and as specified herein..

#### 2.2.2.4 Distribution Sections

The distribution section(s) shall consist of molded-case circuit breakers as indicated. Provide breakers 600 ampere and above with solid state electronic trip unit. The solid state electronic trip unit shall include adjustments for long time, short time, instantaneous and ground fault, including I2t for each and as specified herein.

#### 2.2.3 Protective Device

Provide main and branch protective devices as indicated.

##### 2.2.3.1 Insulated-Case Breaker

UL listed, 100 percent rated, stationary, 120 Vac, electrically operated, low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated at indicated volts. Breaker frame size shall be as indicated. Equip electrically operated breaker with motor-charged, stored-energy closing mechanism to permit rapid and safe closing of the breaker against fault currents within the short time rating of the breaker, independent of the operator's strength or effort in closing the handle.

##### 2.2.3.2 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 80 percent rated, stationary, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of rms symmetrical amperes as indicated. Breaker frame size shall be as indicated. Series rated circuit breakers are unacceptable.

#### 2.2.4 Electronic Trip Units

Equip main and distribution breakers 600 ampere and above, with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be the same as the breaker frame rating. The trip unit ampere rating shall be as indicated. Ground fault protection shall be zero sequence sensing or residual type sensing. The electronic trip units shall have the following features and as indicated.

- a. Breakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.
- b. Breakers shall have short delay pick-up and time settings and, instantaneous settings and ground fault settings.
- c. Distribution breakers, 600 ampere and above, shall have long delay pick-up and time settings, short delay pick-up and time settings, instantaneous

settings, and ground fault settings.

- d. Main Breakers shall have a digital display for phase and ground current.
- e. Main Breakers shall have a digital display for watts, vars, VA, kWh, kvarh, and kVAh.
- f. Main Breakers shall have a digital display for phase voltage, and percent THD voltage and current.

#### 2.2.5 Instruments

Provide current transformers and voltage transformers where required for metering specified herein. Provide 2% minimum accuracy current transformers and voltage transformers when provided.

##### 2.2.5.1 [Enter Appropriate Subpart Title Here] 2.3 NAMEPLATES

Provide phenolic type white on black for each protective device.

#### 2.4 SOURCE QUALITY CONTROL

##### 2.4.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

###### a. Test Instrument Calibration

- (1) The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- (2) The accuracy shall be directly traceable to the National Institute of Standards and Technology.
- (3) Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels shall be visible on all test equipment.
- (5) Calibrating standard shall be of higher accuracy than that of the instrument tested.
- (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
  - (b) Identify the third party/laboratory calibrated instrument

to verify that calibrating standard is met.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

#### 3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

##### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 16375. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

##### 3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the exterior perimeter ground ring.

##### 3.2.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

#### 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

##### 3.3.1 Switchboard

NEMA PB 2.1.

##### 3.3.2 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

#### 3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

##### 3.4.1 Interior Location

Floor or substructure mount switchboard. Provide a t 4 inches thick housekeeping concrete pad for switchboards mounted on structural slab flooring. Provide a 1/2 inch chamfer for housekeeping concrete pads. The housekeeping pad shall be of adequate size to project at least 8 inches beyond the equipment. Where switchboard is mounted in an area that has raised access flooring, provide substructure steel supports for the switchboard independent of the raised access flooring. Substructure support for switchboards shall be independent of the raised access flooring and shall be of sufficient height to make the bottom of the switchboard flush with the top of the raised access flooring..

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

##### 3.5.1.1 Switchboard Assemblies

###### a. Visual and Mechanical Inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical, electrical, and mechanical condition.
- (3) Confirm correct application of manufacturer's recommended lubricants.
- (4) Verify appropriate anchorage, required area clearances, and correct alignment.
- (5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
- (6) Verify that circuit breaker sizes and types correspond to approved shop drawings.
- (7) Verify that current transformer ratios correspond to approved shop drawings.
- (8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- (10) Clean switchboard.
- (11) Inspect insulators for evidence of physical damage or contaminated surfaces.
- (12) Verify correct barrier installation .
- (13) Exercise all active components.
- (14) Inspect all mechanical indicating devices for correct operation.
- (15) Verify that vents are clear.
- (16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.
- (17) Inspect control power transformers.

b. Electrical Tests

- (1) Perform insulation-resistance tests on each bus section.
- (2) Perform overpotential tests.
- (3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.
- (4) Perform control wiring performance test.
- (5) Perform primary current injection tests on the entire current circuit in each section of assembly.
- (6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.5.1.2 Circuit Breakers

Insulated-Case and Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

- (1) Compare nameplate data with specifications and approved shop drawings.
- (2) Inspect circuit breaker for correct mounting.
- (3) Operate circuit breaker to ensure smooth operation.
- (4) Inspect case for cracks or other defects.
- (5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.
- (6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

- (1) Perform contact-resistance tests.
- (2) Perform insulation-resistance tests.
- (3) Perform Breaker adjustments for final settings in accordance with Government provided settings.
- (4) Perform long-time delay time-current characteristic tests
- (5) Determine short-time pickup and delay by primary current injection.
- (6) Determine ground-fault pickup and time delay by primary current injection.
- (7) Determine instantaneous pickup current by primary injection.

(8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

### 3.5.1.3 Grounding System

#### a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

#### b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

### 3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

## SECTION 16475

COORDINATED POWER SYSTEM PROTECTION  
10/96

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.11	(1987; R 1993) Instrumental Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV Through 69 kV NSV)
ANSI C37.16	(1997) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C37.50	(1989; R 1995) Switchgear Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.13	(1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C57.13	(1993) Instrument Transformers
IEEE Std 242	(1986; R 1991) IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE Std 399	(1997) Recommended Practice for Industrial and Commercial Power Systems Analysis

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Controls and Systems
NEMA ICS 2	(1993) Industrial Control and Systems,

Controllers, Contractors Overload Relays  
Rated not More Than 2,00 Volts AC or 750  
Volts DC

NEMA ICS 3 (1993) Industrial Control and Systems  
Factory Built Assemblies

NEMA ICS 6 (1993) Industrial Control and Systems,  
Enclosures

NEMA SG 2 (1993) High Voltage Fuses

NEMA SG 3 (1995) Power Switching Equipment

NEMA SG 5 (1995) Power Switchgear Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 486E (1994; Rev Feb 1997) Equipment Wiring  
Terminals for Use with Aluminum and/or  
Copper Conductors

UL 489 (1996; Rev thru Dec 1998) Molded-Case  
Circuit Breakers Molded-Case Switches, and  
Circuit-Breaker Enclosures

UL 508 (1993; Rev thru Oct 1997) Industrial  
Control Equipment

UL 845 (1995; Rev Feb 1996) Motor Control Centers

UL 877 (1993; Rev thru May 1997) Circuit Breakers  
and Circuit-Breaker Enclosures for Use in  
Hazardous (Classified) Locations

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis; G, AE.

Protective Device Coordination Study; G, AE.

The study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted

for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Equipment; G, AE.

Data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

System Coordinator; G, AE.

Verification of experience and license number, of a registered Professional Engineer with at least four years of current experience in the design of coordinated power system protection. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers. This engineer must perform items required by this section to be performed by a registered Professional Engineer.

Installation; G, AE.

Procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

#### SD-06 Test Reports

Field Testing; G, AE.

The proposed test plan, prior to field tests. Plan shall consist of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used. Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

#### SD-07 Certificates

Devices and Equipment; G, AE.

Certificates certifying that all devices or equipment meet the requirements of the contract documents.

### 1.3 SYSTEM DESCRIPTION

The power system covered by this specification consists of: The 22KV switchgear at the corner of Elm Street and Sweeny Avenue down to 10,000 amperes available on the 208 volt system inside the facility.

### 1.4 QUALIFICATIONS

#### 1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a registered professional electrical power engineer with a minimum of two years of current experience in the coordination of electrical power systems.

#### 1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

#### 1.6 PROJECT/SITE CONDITIONS

Devices and equipment furnished under this section shall be suitable for the following site conditions. Seismic details shall conform 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

##### 1.6.1 Altitude

Altitude: 50 feet

##### 1.6.2 Ambient Temperature

Ambient Temperature:

##### 1.6.3 Frequency

Frequency: 60

##### 1.6.4 [Enter Appropriate Subpart Title Here]

##### 1.6.5 Hazardous Classification

Hazardous Classification: NA

##### 1.6.6 Humidity Control

Humidity Control: Salt Environment

#### PART 2 PRODUCTS

##### 2.1 STANDARD PRODUCT

Protective devices and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory utility type use for at least two years prior to bid opening.

##### 2.2 NAMEPLATES

Nameplates shall be provided to identify all protective devices and equipment. Nameplate information shall be in accordance with NEMA AB 1, NEMA SG 3, or NEMA SG 5 as applicable.

### 2.3 CORROSION PROTECTION

Metallic materials shall be protected against corrosion. Ferrous metal hardware shall be zinc or chrome-plated.

### 2.4 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

Motor controls and motor control centers shall be in accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.

#### 2.4.1 Motor Starters

#### 2.4.2 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

#### 2.4.3 Low-Voltage Motor Overload Relays

##### 2.4.3.1 General

Thermal and magnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 second. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

##### 2.4.3.2 Construction

Manual reset type thermal relays shall be melting alloy or bimetallic construction. Automatic reset type relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

##### 2.4.3.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than 14 degrees F, an ambient temperature-compensated overload relay shall be provided.

#### 2.4.4 Automatic Control Devices

##### 2.4.4.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

##### 2.4.4.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

##### 2.4.4.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- b. Connections to the selector switch shall only allow the normal automatic regulatory control devices to be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

#### 2.5 LOW-VOLTAGE FUSES

##### 2.5.1 General

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics requires for effective power system coordination.

##### 2.5.2 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK1 RK5 shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

- b. Class K fuses shall conform to UL 198D.
- c. Class R fuses shall conform to UL 198E.

### 2.5.2.1 Continuous Current Ratings (600 amperes and smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK5 , current-limiting, time-delay with 200,000 amperes interrupting capacity.

### 2.5.2.2 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

## 2.6 MEDIUM-VOLTAGE AND HIGH-VOLTAGE FUSES

### 2.6.1 General

Medium-voltage and high-voltage fuses shall conform to NEMA SG 2 and shall be distribution fuse cutouts or power fuses, E-rated, C-rated, or R-rated current-limiting fuses as specified.

### 2.6.2 Construction

Units shall be suitable for outdoor indoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

### 2.6.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Continuous-current ratings shall be as shown.

#### 2.6.3.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the loadbreakopen type construction rated 15 kV and of the heavy-duty type for 5KV system. Open-link cutouts are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuses cutouts shall be equipped with mounting brackets suitable for the indicated installations.

#### 2.6.3.2 Power Fuses

Current-limiting power fuses shall have ratings in accordance with ANSI C37.46 and as follows:

- a. Nominal voltage.....25KV
- b. Rated maximum voltage.....27kv
- c. Maximum symmetrical interrupting capacity.....12000
- d. Rated continuous current.....200 amperes
- e. BIL.....125 kv

#### 2.6.3.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

#### 2.6.3.4 C-Rated, Current-Limiting Fuses

C-rated, current-limiting, power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

#### 2.6.3.5 R-Rated, Current-Limiting Fuses

R-rated, current-limiting, fuses shall be used with medium-voltage motor controllers only. R-rated fuses shall conform to ANSI C37.46.

### 2.7 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

#### 2.7.1 General

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

#### 2.7.2 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

#### 2.7.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA 0	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

### 2.8 MOLDED-CASE CIRCUIT BREAKERS

#### 2.8.1 General

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers. Circuit breakers and circuit breaker enclosures located in hazardous (classified) areas shall conform to UL 877.

### 2.8.2 Construction

Molded-case circuit breakers shall be assembled as an integral unit in a supporting and enclosing housing of glass reinforced insulating material providing high dielectric strength. Circuit breakers shall be suitable for mounting and operating in any position. Lugs shall be listed for copper and aluminum conductors in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

### 2.8.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

### 2.8.4 Cascade System Ratings

Circuit breakers used in series combinations are not acceptable

### 2.8.5 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 650 amperes.

### 2.8.6 Solid-State Trip Elements

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroidal construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100

percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

- a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.
- b. Fixed long-time delay.
- c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- d. Adjustable short-time delay.
- e. Short-time  $I^2 t$  switch.
- f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. Zone-selective interlocking shall be provided as shown.
- h. Adjustable ground-fault delay.
- i. Ground-fault  $I^2 t$  switch.
- j. Overload and Short-circuit and Ground-fault trip indicators shall be provided.

#### 2.8.7 Current-Limiting Circuit Breakers

Current-limiting circuit breakers shall be provided as shown. Current-limiting circuit breakers shall limit the let-through  $I^2 t$  to a value less than the  $I^2 t$  of one-half cycle of the symmetrical short-circuit current waveform. On fault currents below the threshold of limitation, breakers shall provide conventional overload and short-circuit protection. Integrally-fused circuit breakers shall not be used.

#### 2.8.8 SWD Circuit Breakers

Circuit breakers rated 15 amperes or 20 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

#### 2.8.9 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

#### 2.8.10 Motor Circuit Protectors (MCP)

Motor circuit protectors shall conform to NEMA AB 1 and UL 489 and shall be provided as shown. MCPs shall consist of an adjustable instantaneous trip circuit breaker in conjunction with a combination motor controller which provides coordinated motor circuit overload and short-circuit protection.

Motor Circuit Protectors shall be rated in accordance with NFPA 70.

## 2.9 LOW-VOLTAGE POWER CIRCUIT BREAKERS

### 2.9.1 Construction

Low-voltage power circuit breakers shall conform to IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, electrically operated, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact position indicator, charged/discharged stored energy indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of the primary disconnects when the circuit breaker is closed. Control voltage shall be 24 V dc or 48 V dc or 120 V ac . The circuit breaker enclosure shall be suitable for its intended location.

### 2.9.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

- a. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.
- b. Adjustable long-time delay.
- c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- d. Adjustable short-time delay.
- e. Short-time I square times t switch.
- f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. Zone-selective interlocking shall be provided as shown.
- h. Adjustable ground-fault delay.
- i. Ground-fault I square times t switch.
- j. Overload and Short-circuit and Ground-fault trip indicators shall be provided.

## 2.10 INSTRUMENT TRANSFORMERS

### 2.10.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13.

Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on the drawings.

#### 2.10.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than 2.0. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

##### 2.10.2.1 Current Transformers for Power Transformers

Single-ratio bushing type current transformers shall be provided internally around power transformer bushings as shown. Single-ratio units shall have a minimum metering accuracy class of 0.3B-0.5.

##### 2.10.2.2 Current Transformers for KW Hour and Demand Metering (Low Voltage)

Current transformers shall conform to IEEE C57.13. Current transformers with a metering accuracy Class of 0.3 through 1.8, with a minimum RF of 1.33 at 86 degrees F, with 600-volt insulation, and 10 kV BIL shall be provided. Butyl-molded, window-type current transformers mounted on the transformer low-voltage bushings shall be provided. Route current transformer leads in a location as remote as possible from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters.

##### 2.10.2.3 Voltage Transformers

Voltage transformers shall have indicated ratios or as required. Units shall have an accuracy rating of 0.3. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.

#### 2.11 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, and a protective device coordination study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last three years. The Contractor shall provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

### 2.11.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus at the corner of Elm Street and Sweeney Avenue.\ and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 208 volt level distribution buses. the source bus and extended through the secondary side of transformers for medium voltage distribution feeders.

### 2.11.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. The Contractor shall coordinate with the Contracting Officer for fault current availability at the site.

### 2.11.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

### 2.11.4 Fault Current Analysis

#### 2.11.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

#### 2.11.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

#### 2.11.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

### 2.11.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of

any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

#### 2.11.6 Study report

- a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.
- c. The report shall document utility data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings;
- d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.
- e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

### PART 3 EXECUTION

#### 3.1 VERIFICATION OF DIMENSIONS

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 3.2 INSTALLATION

Protective devices shall be installed in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.

#### 3.3 FIELD TESTING

##### 3.3.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 14 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed,

personnel involved, devices tested, serial number and name of test equipment, and test results.

### 3.3.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.3.3 Molded-Case Circuit Breakers

Circuit breakers shall be visually inspected, operated manually, and connections checked for tightness. Current ratings shall be verified and adjustable settings incorporated in accordance with the coordination study.

### 3.3.4 Power Circuit Breakers

#### 3.3.4.1 General

The Contractor shall visually inspect the circuit breaker and operate the circuit breaker manually; adjust and clean primary contacts in accordance with manufacturer's published instructions; check tolerances and clearances; check for proper lubrication; and ensure that all connections are tight. For electrically operated circuit breakers, the Contractor shall verify operating voltages on closing and tripping coils. The Contractor shall verify fuse ratings in control circuits; electrically operate the breaker, where applicable; and implement settings in accordance with the coordination study.

#### 3.3.4.2 Power Circuit Breaker Tests

All power circuit breakers shall be tested in accordance with ANSI C37.50.

### 3.3.5 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

-- End of Section --

## SECTION 16528

EXTERIOR LIGHTING  
02/95

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO LTS-3 (1994) Standard Specifications for  
Structural Supports for Highway Signs,  
Luminaires and Traffic Signals

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.1 (1991; C78.1a; R 1996) Fluorescent Lamps -  
Rapid-Start Types - Dimensional and  
Electrical Characteristics

ANSI C78.1350 (1990) Electric Lamps - 400-Watt, 100-Volt,  
S51 Single-Ended High-Pressure Sodium Lamps

ANSI C78.1355 (1989) Electric Lamps - 150-Watt, 55-Volt  
S55 High-Pressure Sodium Lamps

ANSI C82.4 (1992) Ballasts for  
High-Intensity-Discharge and Low-Pressure  
Sodium Lamps (Multiple-Supply Type)

ANSI C119.1 (1986; R 1997) Sealed Insulated Underground  
Connector Systems Rated 600 Volts

ANSI C136.2 (1996) Luminaires, Voltage Classification  
Roadway Lighting Equipment

ANSI C136.3 (1995) Roadway Lighting Equipment-Luminaire  
Attachments

ANSI C136.6 (1997) Roadway Lighting Equipment - Metal  
Heads and Reflector Assemblies - Mechanical  
and Optical Interchangeability

ANSI C136.9 (1990) Roadway Lighting - Socket Support  
Assemblies for Use in Metal Heads -  
Mechanical Interchangeability

ANSI C136.10 (1996) Roadway Lighting- Locking-Type  
Photocontrol Devices and Mating Receptacles  
- Physical and Electrical  
Interchangeability and Testing

ANSI C136.11	(1995) Multiple Sockets for Roadway Lighting Equipment
ANSI C136.15	(1986) Roadway Lighting, High-Intensity-Discharge and Low-Pressure Sodium Lamps in Luminaires -
AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)	
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 2	(1994) Medium-Hard-Drawn Copper Wire
ASTM B 8	(1995) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)	
IESNA RP-8	(1983; R 1993) Roadway Lighting
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE C2	(1997) National Electrical Safety Code
IEEE C136.13	(1987; R 1997) Metal Brackets for Wood Poles
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures

NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 9	(1990) Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 44	(1997; Rev Mar 1999) Rubber-Insulated Wires and Cables
UL 467	(1993; Rev Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connections for Use with Aluminum Conductors
UL 514B	(1996; R Oct 1998) Fittings for Conduit and Outlet Boxes
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev thru Apr 1998) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 854	(1996; Rev Apr 1998) Service-Entrance Cables
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1571	(1995; Rev thru Jun 1997) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 1997) High Intensity Discharge Lighting Fixtures

## 1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01110 SPECIAL CONDITIONS

### SD-02 Shop Drawings

Lighting System; G, AE.

Detail Drawings; G, AE.

Detail drawings for the complete system and for poles, lighting fixtures, bracket arms, cable boxes, handholes, . Detail drawings for precast handholes shall include a design analysis to determine

that strength is equivalent to indicated cast-in-place concrete handholes.

As-Built Drawings; G.

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

#### SD-03 Product Data

Equipment and Materials; G, AE.

Data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is otherwise suitable for the application and fully conforms to the requirements specified.

Spare Parts; G.

Spare parts data for each item of material and equipment specified, after approval of detail drawings for materials and equipment, and not later than 4 months before the date of beneficial occupancy. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and sources of supply.

#### SD-06 Test Reports

Operating Test; G.

Test procedures and reports for the Operating Test. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. The final test procedures report shall be delivered after completion of the tests.

Ground Resistance Measurements; G.

The measured resistance to ground of each separate grounding installation, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made. The information shall be in writing.

#### SD-10 Operation and Maintenance Data

Lighting System; G.

A draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. The draft copy used during site testing shall be updated with any changes required, prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The

manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the field test shall include modifications made during installation checkout and acceptance.

### 1.3 SYSTEM DESCRIPTION

#### 1.3.1 Lighting System

The lighting system shall be configured as specified and shown. The system shall include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

#### 1.3.2 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

#### 1.3.3 Interface Between Lighting System and Power Distribution

Conductors shall be as indicated.

#### 1.3.4 Nameplates

Each major component of equipment shall have a nonferrous metal or engraved plastic nameplate which shall show, as a minimum, the manufacturer's name and address, the catalog or style number, the electrical rating in volts, and the capacity in amperes or watts.

#### 1.3.5 Standard Products

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

### 1.4 CORROSION PROTECTION

#### 1.4.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

#### 1.4.2 Ferrous Metal Materials

##### 1.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

##### 1.4.2.2 Equipment

Equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat

to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall have a rating of not less than 7 in accordance with TABLE 1, (procedure A) of ASTM D 1654. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

### 2.2 BRACKET ARMS

#### 2.2.1 On Aluminum Poles

Poles shall be provided with bracket arms of the support arm style and of the length indicated on drawings. Bracket arms shall conform to the design of the pole provided. The bracket arms shall be capable of supporting the equipment to be mounted on it with the maximum wind and ice loading encountered at the site. Strength of bracket arms shall be in accordance with IEEE C136.13. Steel brackets shall be galvanized. Wood bracket arms shall not be used.

### 2.3 CABLE

The Contractor shall provide all wire and cable not indicated as government furnished equipment. Wire and cable components shall be able to withstand the jobsite environment for a minimum of 20 years.

#### 2.3.1 Insulated Cable

Cable shall be type USE conforming to UL 854, with copper conductors and type RHW or XHHW insulation conforming to UL 44, and shall include green ground conductor. Cable shall be provided with insulation of a thickness not less than that given in column A of TABLE 15.1 of UL 854. Cable shall be rated 600 volts. Parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded.

#### 2.3.2 Bare Copper Conductors

Medium-hard-drawn copper conductors shall conform to ASTM B 2 and ASTM B 8.

### 2.4 CABLE SPLICES AND CONNECTORS

Cable splices and connectors shall conform to UL 486A. Underground splices and connectors shall also conform to the requirements of ANSI C119.1.

### 2.5 CABLE BOXES

Boxes and covers shall be made of cast iron with zinc coated or aluminized finish, and shall be of the sizes indicated on drawings. The minimum

inside dimensions shall be not less than 12 inches square by 6 inches deep and not less than required to house the cable splice. A suitable gasket shall be installed between the box and cover for watertightness. A sufficient number of screws shall be installed to hold the cover in place along the entire surface of contact. Grounding lugs shall be provided.

## 2.6 HANDHOLES

Handholes shall be as indicated. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast concrete manholes shall have the required strength established by ASTM C 478. A machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5,000 psi. Pullbox and handhole covers in parking lots, sidewalks, and turfed areas shall be of the same material as the box.

## 2.7 CONDUIT, DUCTS AND FITTINGS

### 2.7.1 Conduit Fittings and Outlets

#### 2.7.1.1 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

### 2.7.2 Non-Metallic Duct

Non-metallic duct lines and fittings utilized for underground installation shall be suitable for the application. Duct shall be thick-wall, single, round-bore type. Material of one type shall be used. Acrylonitrile-butadiene-styrene (ABS) duct shall conform to NEMA TC 6 and NEMA TC 9. High-density conduit shall conform to UL 651A. Schedule 40 polyvinyl chloride (PVC) shall conform to UL 651. Plastic utility duct and fittings manufactured without a UL label or listing shall be provided with a certification as follows: "The materials are suitable for use with 167 degree F wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

## 2.8 GROUND RODS

Ground rods shall be of copper clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into earth.

## 2.9 POLES

Metal poles shall be the pole manufacturer's standard design for supporting the number of fixtures indicated. Poles shall be designed for a wind velocity of 120 at the base of the pole, for a wind gust factor of 1.3, with fixtures installed, and for the height and drag factors recommended by AASHTO LTS-3. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. The type of pole shaft material

provided shall not be mixed on any project. Grounding connection shall be provided near the bottom of each metal pole and at each concrete pole anchor base. Scratched, stained, chipped, or dented poles shall not be installed.

#### 2.9.1 Aluminum Poles

Aluminum poles and brackets for lighting shall have a dark anodic bronze finish to match fixtures and shall not be painted. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

- a. Shafts shall be round and of seamless construction. The wall thickness shall be at least 0.188 inch. Exterior surfaces shall be free of protuberances, dents, cracks, and discoloration. Material for shafts shall be 6063 aluminum alloy; after fabrication, the alloy shall have a T6 temper. Tops of shafts shall be fitted with a round or tapered cover. Bases shall be anchor bolt mounted, made of cast aluminum alloy 356-T6, and shall be machined to receive the lower end of shafts. Joints between shafts and bases shall be welded. Bases shall be provided with four holes, spaced 90 degrees apart, for anchorage.
- b. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.

#### 2.9.2 Anchor Bolts

Anchor bolts shall be the pole manufacturer's standard, but not less than necessary to meet the pole wind and ice loading, herein and other specified design requirements.

### 2.10 ILLUMINATION

#### 2.10.1 General Lighting

Luminaires, ballasts, lamps, and control devices required for lighting shall be in accordance with details indicated

#### 2.10.2 [Enter Appropriate Subpart Title Here]

#### 2.11 LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

##### 2.11.1 High-Pressure Sodium

Lamps shall conform to ANSI C78.1350 or ANSI C78.1355, respectively. Ballasts shall conform to ANSI C82.4, or UL 1029. High-pressure sodium lamps shall be clear.

#### 2.12 LUMINAIRE COMPONENTS

Luminaire components shall conform to the following: attachments, ANSI C136.3; voltage classification, ANSI C136.2; field identification marking, ANSI C136.15; interchangeability, ANSI C136.6 and ANSI C136.9; and sockets, ANSI C136.11.

#### 2.13 LIGHTING CONTROL EQUIPMENT

##### 2.13.1 Photo-Control Devices

Photo-control devices shall conform to ANSI C136.10. Each photo-control element shall be a replaceable, weatherproof, plug-in or twist-lock assembly adjustable operation range of approximately 0.5 to 5.0 foot-candles. Luminaires shall be equipped with weatherproof plug-in or twist-lock receptacle to receive the photo-control element.

#### 2.13.2 Timer Control Switches

Astronomic dial type arranged to turn "ON" at sunset, and turn "OFF" at a pre-determined time between 2030 hours hours and 0230 hours hours or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise shall be provided. A switch rated as indicated volts, having battery backed electronic clock to maintain accurate time for a minimum of 7 hours following a power failure shall be provided. A time switch with a manual on-off bypass switch shall be provided. Housing for the time switch shall be a surface mounted, NEMA 3R enclosure conforming to NEMA ICS 6.

#### 2.13.3 Magnetic Contactor

Magnetic contactors shall be mechanically held, electrically operated, and shall conform to NEMA ICS 1 and NEMA ICS 2. The contactor shall be suitable for 480 volts, single 3 phase, 60 Hz. Coil voltage shall be volts as required. Maximum continuous ampere rating and number of poles shall be as indicated on drawings. Enclosures for contactors mounted indoors shall be NEMA ICS 6, Type 3R. Each contactor shall be provided with a spare, normally open auxiliary contact. Terminal lugs shall be coordinated with the wire size.

#### 2.14 PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to IESNA RP-8.

#### 2.15 LUMINAIRES, FLOODLIGHTING

##### 2.15.1 HID and Incandescent

HID lighting fixtures shall conform to UL 1572. Incandescent lighting fixtures shall conform to UL 1571.

##### 2.15.2 Fluorescent

Fluorescent lamps shall conform to ANSI C78.1.

#### 2.16 FIXTURES

Standard fixtures shall be as detailed on drawings. Illustrations shown on or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality will be acceptable as approved.

##### 2.16.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

##### 2.16.2 In-Line Fuse

An in-line fuse shall be provided for each fixture, and shall consist of a fuse and a UL approved waterproof fuse holder rated at 30 amperes, 600 volts, with insulated boots. Fuse rating shall be 600 volts.

### PART 3 EXECUTION

#### 3.1 GENERAL

The Contractor shall install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2, and contract documents, and shall furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

##### 3.1.1 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government. The Contractor shall not take any corrective action without written permission from the Government.

#### 3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

#### 3.3 PREVENTION OF CORROSION

##### 3.3.1 Aluminum

Aluminum shall not be used in contact with earth or concrete, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

##### 3.3.2 Steel Conduits

Steel conduits shall not be installed .

#### 3.4 CABLE INSTALLATION

Cable and all parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber or nonferrous metal tags, or approved equal, in each handhole and junction box, and at each terminal.

##### 3.4.1 Splices

Splices below grade shall be made with nonpressure-filled resin systems

using transparent, interlocking, self-venting, longitudinally split plastic molds. Splices above grade shall be made with sealed insulated pressure connectors and shall provide insulation and jacket equal to that of the cable. In order to prevent moisture from entering the splice, jackets shall be cut back to expose the required length of insulation between the jacket and the tapered end of the insulation.

#### 3.4.2 Installation in Duct Lines

Ground conductors shall be installed in duct with the associated phase conductors. Cable splices shall be made in handholes only.

#### 3.4.3 Direct Burial

### 3.5 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated and shall be properly connected to the indicated equipment. Empty conduits to the indicated equipment from a point 5 feet outside the building wall and 2 feet below finished grade are specified in Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed to prevent moisture or gases from entering the building.

### 3.6 DUCT LINES

#### 3.6.1 Requirements

Numbers and size of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inches in diameter, and 36 inches for duct 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells when duct lines terminate in manholes or handholes.

#### 3.6.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and shall match factory tapers. A coupling recommended by the duct manufacturer shall be used when an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.6.3 Concrete Encasement

Ducts shall comply with NFPA 70. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the

existing encasement. At any point, except railroad and airfield crossings, tops of concrete encasements shall not be less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface landings. Tops of concrete encasement shall not be less than 5 feet below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit shall be installed. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method shall be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not more than 4 foot on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete, and joints shall be staggered at least 6 inches vertically.

#### 3.6.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved.

##### 3.6.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4 turn to set the joint tightly.

##### 3.6.5 Concrete

Concrete shall be plain, 3000 psi at 28 days, Duct line encasement shall be of monolithic construction. Where a connection is made to an existing duct line, the concrete encasement shall be well bonded or doweled to the existing encasement.

##### 3.6.6 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other duct locations that are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

#### 3.7 HANDHOLES

The exact locations shall be determined after carefully considering the locations of other utilities, grading, and paving. Exact locations shall be approved before construction is started.

#### 3.8 POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height of as indicated. Electrical cabling shall be provided to the light pole as specified. Pole installation shall conform to the manufacturer's recommendations, NFPA

70, and IEEE C2. Poles shall be set straight and plumb.

### 3.8.1 Pole Brackets

Brackets shall be installed as specified by the manufacturer and as shown on drawings.

### 3.8.2 Concrete Foundations

Concrete foundations shall have anchor bolts accurately set in the foundation using a template supplied by the pole manufacturer. Once the concrete has cured, the pole shall be set on the foundation, leveled on the foundation bolts, and secured with the holding nuts. The space between the foundation and the pole base shall be grouted. Concrete shall be 3000 psi at 28 days.

### 3.8.3 Aluminum Pole Installation

Poles shall be mounted on reinforced concrete. Conduit elbows shall be provided for cable entrances into pole interiors.

#### 3.8.3.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturer's standard, and not less than necessary to meet the pole wind loading and other specified design requirements.

## 3.9 LIGHTING

### 3.9.1 Lamps

Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original containers and installed in the fixtures just before completion of the project.

### 3.9.2 Fixture Installation

Standard fixtures shall be installed as detailed drawings.

#### 3.9.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be installed as required for proper installation.

#### 3.9.2.2 In-Line Fuses

An in-line fuse shall be provided for each fixture.

## 3.10 LIGHTING CONTROL SYSTEM

### 3.10.1 Photo-Control

Lighting luminaires shall be controlled in banks by a single photo-control element mounted within each bank.

### 3.10.2 Time Control Switches

Switches shall be installed with not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

### 3.10.3 Manual and Safety Switches

Terminal lugs shall be coordinated with the wire size. Switches shall be securely fastened to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

### 3.10.4 Magnetic Contactors

Terminal lugs shall be coordinated with the wire size. Switches shall be securely fastened to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

## 3.11 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following. Grounding conductors shall be soft-drawn, stranded copper. Ground rods shall be driven into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade, except in handholes.

### 3.11.1 Ground Rod Electrodes

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground rod shall not exceed 10 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes shall be up to three, 10 feet long rods spaced a minimum of 10 feet apart 3/4 inch in diameter, up to 30 feet 30 feet long, driven perpendicular to grade. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 10 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.11.2 Items to be Grounded

Ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment shall be grounded. Connections above grade shall be made with solderless connectors, and those below grade shall be made by a fusion-welding process.

### 3.11.3 Lighting Pole

One ground rod shall be provided at each pole. Bases of metal or concrete lighting poles shall be connected to ground rods by means of No. 8 AWG bare copper wire. Lighting fixture brackets on wood and concrete poles shall be grounded to a No. 6 AWG bare copper grounding conductor connected to the ground rod.

### 3.11.4 Handhole

In each handhole, at a convenient point close to the wall, a ground rod shall be driven into the earth before the floor is poured, and approximately 4 inches of the ground rod shall extend above the floor after pouring. When precast concrete units are used, the top of the ground rod may be below the floor, and a No. 1/0 AWG copper ground conductor shall be brought inside through a watertight sleeve in the wall. Connection to ground rods shall be by means of bolted-clamp terminals or by an approved fusion-welding process. Ground wires shall be neatly and firmly attached to handhole walls, and the amount of exposed bare wire shall be held to a minimum.

### 3.12 TESTS

#### 3.12.1 Operating Test

After the installation is completed and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements specified. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test, and the Government will furnish the necessary electric power.

#### 3.12.2 Ground Resistance Measurements

The resistance to ground shall be measured by the fall-of-potential method described in IEEE Std 81.

The contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "as-built" drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the lighting system. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the as-built drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and shall complete the work as required.

-- End of Section --

SECTION 16710

PREMISES DISTRIBUTION SYSTEM

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## SECTION 16751

CLOSED CIRCUIT TELEVISION SYSTEM (EACH SYSTEM)  
08/00

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

## ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 170 (1957) Electrical Performance Standards -  
Monochrome Television Studio Facilities

EIA ANSI/EIA/TIA-232-F (1997) Interface Between Data Terminal  
Equipment and Data Circuit-Terminating  
Equipment Employing Serial Binary Data  
Interchange

EIA ANSI/EIA-310-D (1992) Cabinets, Racks, Panels, and  
Associated Equipment

EIA ANSI/EIA-375-A-1976 (1974) Electrical Performance Standards for  
Direct View Monochrome Closed Circuit  
Television Monitors 525/60 Interlaced 2:1

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

IEEE C62.41 (1991; R 1995) Surge Voltages in  
Low-Voltage AC Power Circuits

IEEE Std 142 (1991) IEEE Recommended Practice for  
Grounding of Industrial and Commercial  
Power Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## 1.2 SYSTEM DESCRIPTION

## 1.2.1 General

There are multiple closed circuit television system required for this project, that monitor specific areas, but are also interconnected and remotely monitored at the main security room (ECP) at the main entrance to the facility. The Contractor shall configure the system as described and shown. All television equipment shall conform to EIA 170 specifications. The system shall include all equipment, consoles, controls, monitors, switching, recording, connectors, adapters, terminators, etc., necessary to interconnect all equipment and for a complete installation. The Contractor shall also supply all cabling necessary to interconnect the closed circuit television (CCTV) equipment installed in the Security Center, and interconnect equipment installed at remote control/monitoring stations. If the CCTV system is installed for use with an Electronic Security System (ESS), or required to be interconnected to the ESS, the Contractor shall interface the CCTV system with the ESS.

#### 1.2.2 System Overall Reliability Requirement

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF) of at least 10,000 hours, and shall be calculated based on the configuration specified in paragraph "System Overall Reliability Calculations."

#### 1.2.3 Power Line Surge Protection

All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

#### 1.2.4 Video and Sync Signal Transmission Line Surge Protection

All cable, except fiber optic cable, used for sync or video signal transmission shall include protective devices to safeguard the CCTV equipment against surges. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. The surge suppression device shall be capable of dissipating not less than 1500 watts for 1 millisecond, and the response time from zero volts to clamping shall not be greater than 5 nanoseconds. Fuses shall not be used for surge protection.

#### 1.2.5 Control Line Surge Protection

All cables and conductors, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against surges and shall have surge protection installed at each end. Protection shall be furnished at the equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following waveforms:

- a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.
- b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

#### 1.2.6 Power Line Conditioners

A power line conditioner shall be furnished for the security console CCTV equipment. The power line conditioner used for the CCTV equipment shall be the same one as provided for Section 13720 ELECTRONIC SECURITY SYSTEM. The power line conditioner shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner shall be sized for 125 percent of the actual connected kVA load. Characteristics of the power line conditioner shall be as follows:

- a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
- b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.
- c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

#### 1.2.7 Video and Control Signal Data Transmission Media

The Contractor shall provide a video and data and control signal transmission system.

#### 1.2.8 Environmental Conditions

##### 1.2.8.1 Field Equipment

The cameras and all other field equipment shall be rated for continuous operation under ambient environmental conditions of 14 degrees to 120 degrees F using no auxiliary heating or cooling equipment. Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, wind loading, ice loading, and vibration conditions specified or encountered for the installed location.

##### 1.2.8.2 Security Center Equipment

Security Center and remote control/monitoring station equipment shall, unless designated otherwise, be rated for continuous operation under ambient environmental conditions of 60 degrees F to 85 degrees F and a relative humidity of 20 to 80 percent.

#### 1.2.9 Electrical Requirements

Electrically powered equipment shall operate on 120 or 240 volt 60 Hz AC source. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

##### 1.2.10 Uninterruptible Power Supply

All electrical and electronic equipment in the console shall be powered from an UPS. The UPS shall be sized to provide at least 6 hours battery back-up in the event of primary failure. Batteries shall be sealed non-outgassing type.

### 1.3 DELIVERY OF TECHNICAL DATA AND COMPUTER SOFTWARE

All items of computer software and technical data (including technical data which relates to computer software), which are specifically identified in this specification shall be delivered strictly in accordance with the CONTRACT CLAUSES, SPECIAL CONTRACT REQUIREMENTS, Section 01330 SUBMITTAL PROCEDURES, and in accordance with the Contract Data Requirements List (CDRL), DD Form 1423, which is attached to and thereby made a part of this contract. All data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. If the CCTV system is being installed in conjunction with an ESS, the CCTV Technical Data Packages shall be submitted as part of the Technical Data Packages for Section 13720 ELECTRONIC SECURITY SYSTEM.

#### 1.3.1 Group I Technical Data Package

##### 1.3.1.1 System Drawings

The data package shall include the following:

- a. System block diagram.
- b. CCTV system console installation, block diagrams, and wiring diagrams.
- c. Security center CCTV equipment installation, interconnection with console equipment, block diagrams and wiring diagrams.
- d. Remote control/monitoring station installation, interconnection to security center including block diagrams and wiring diagrams.
- e. Camera wiring and installation drawings.
- f. Pan/tilt mount wiring and installation drawings.
- g. Interconnection with video signal transmission system, block diagrams and wiring diagrams.
- h. Surge protection device installation.
- i. Details of interconnection with ESS.

##### 1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials and equipment and security center equipment provided under this specification.

##### 1.3.1.3 System Description and Analyses

The data package shall include complete system descriptions, analyses and calculations used in sizing the equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

- a. Switcher matrix size.
- b. Camera call-up response time.

- c. System start up and shutdown operations.
- d. Switcher programming instructions.
- e. Switcher operating and maintenance instructions.
- f. Manuals for CCTV equipment.
- g. Data entry forms.

#### 1.3.1.4 Software Data

The data package shall consist of descriptions of the operation and capability of system and application software as specified.

#### 1.3.1.5 Overall System Reliability Calculations

The data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability. The calculations shall be based on all CCTV equipment associated with one camera circuit and the console CCTV equipment, excluding the data transmission media (DTM).

#### 1.3.1.6 Certifications

All specified manufacturer's certifications shall be included with the data package.

#### 1.3.1.7 Key Control Plan

The Contractor shall provide a key control plan as specified in Section 13720 ELECTRONIC SECURITY SYSTEM.

### 1.3.2 Group II Technical Data Package

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall submit a report to the Government documenting changes to the site, or conditions that affect performance of the system to be installed. For those changes or conditions which affect system installation or performance, provide (with the report) specification sheets, or written functional requirements to support the findings, and a cost estimate to correct the deficiency. The Contractor shall not correct any deficiency without written permission from the Government.

### 1.3.3 Group III Technical Data Package

The Contractor shall prepare test procedures and reports for the predelivery test. The Contractor shall deliver the predelivery test procedures to the Government for approval. After receipt by the Contractor of written approval of the predelivery test procedures, the Contractor may schedule the predelivery test. The final predelivery test report shall be delivered after completion of the predelivery test.

### 1.3.4 Group IV Technical Data Package

The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to

the Government for approval. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the tests. The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph "Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

#### 1.3.4.1 Operation and Maintenance Manuals

A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

#### 1.3.4.2 Training Documentation

Lesson plans and training manuals for the training phases, including type of training to be provided with a sample training report, and a list of reference material, shall be delivered for approval.

#### 1.3.4.3 Data Entry

The Contractor shall enter all data needed to make the system operational. The Contractor shall deliver the data to the Government on data entry forms, utilizing data from the contract documents, Contractor's field surveys, and all other pertinent information in the Contractor's possession required for complete installation of the data base. The Contractor shall identify and request from the Government, any additional data needed to provide a complete and operational CCTV system. The completed forms shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

#### 1.3.4.4 Graphics

Where graphics are required and are to be delivered with the system, the Contractor shall create and install all graphics needed to make the system operational. Graphics shall have sufficient level of detail for the system operator to assess the alarm. The Contractor shall supply hard copy, color examples at least 8 by 10 inches in size, of each type of graphic to be used for the completed CCTV system. If the video switcher does not use a monitor for display of system information, the Contractor shall provide examples of the video annotation used for camera identification. The graphics examples shall be delivered to the Government for review and approval at least 90 days prior to the Contractor's scheduled need date.

#### 1.3.5 Group V Technical Data Package

Final copies of each of the manufacturer's commercial manuals arranged as specified bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance. The number of copies of each manual to be delivered shall

be as specified on DD Form 1423.

#### 1.3.5.1 Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

#### 1.3.5.2 Hardware Manual

A manual shall describe all equipment furnished, including:

- a. General hardware description and specifications.
- b. Installation and checkout procedures.
- c. Equipment electrical schematics and layout drawings.
- d. System schematics and wiring lists.
- e. System setup procedures.
- f. Manufacturer's repair parts list indicating sources of supply.
- g. Interface definition.

#### 1.3.5.3 Software Manual

The software manual shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation, including:

- a. Definitions of terms and functions.
- b. Procedures for system boot-up.
- c. Description of using the programs.
- d. Description of required operational sequences.
- e. Directory of all disk files.
- f. Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer.

#### 1.3.5.4 Operator's Manual

The operator's manual shall explain all procedures and instructions for operation of the system including:

- a. Video switcher.
- b. Video multiplexer.
- c. Cameras and video recording equipment.

- d. Use of the software.
- e. Operator commands.
- f. System start-up and shut-down procedures.
- g. Recovery and restart procedures.

#### 1.3.5.5 Maintenance Manual

The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### 1.3.5.6 As-Built Drawings

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the CCTV system to be used for as-built drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the CCTV system and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the final system drawings, a representative of the Government will review the final system work with the Contractor. If the final system work is not complete, the Contractor will be so advised and shall complete the work as required. Final drawings submitted with the endurance test report shall be finished drawings on mylar or vellum, and as AutoCAD or Microstation files on CD-ROM.

### 1.4 TESTING

#### 1.4.1 General

The Contractor shall perform predelivery testing, site testing, and adjustment of the completed CCTV system. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific test procedures.

#### 1.4.2 Test Procedures and Reports

Test procedures shall explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

### 1.5 TRAINING

#### 1.5.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. If the CCTV system is being installed in conjunction with an ESS, the CCTV training shall be concurrent and part of the ESS training. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional

manuals delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. Where the Contractor presents portions of the course through the use of audio-visual material, copies of the audio-visual materials shall be delivered to the Government, either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is 8 hours of instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. For guidance in planning the required instruction, the Contractor should assume the attendees will have a high school education or equivalent. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

#### 1.5.2 Operator's Training

The course shall be taught at the project site for two consecutive training days during or after the Contractor's field testing. A maximum of 12 personnel will attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of classroom instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The Contractor shall prepare a written report after the completion of the course. The Contractor shall list in the report the times, dates, attendees and material covered at each training session. The Contractor shall describe the skill level of each student at the end of this course. The Contractor shall submit the report before the end of the performance verification test. The course shall include:

- a. General CCTV hardware, installed system architecture and configuration.
- b. Functional operation of the installed system and software.
- c. Operator commands.
- d. Alarm interfaces.
- e. Alarm reporting.
- f. Fault diagnostics and correction.
- g. General system maintenance.
- h. Replacement of failed components and integration of replacement components into the operating CCTV system.

#### 1.6 MAINTENANCE AND SERVICE

### 1.6.1 General Requirements

The Contractor shall provide all services required and equipment necessary to maintain the entire CCTV system in an operational state as specified for a period of 1 year after completion of the endurance test, and shall provide all necessary material required for the work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other unscheduled work.

### 1.6.2 Description of Work

The adjustment and repair of the CCTV system includes all computer equipment, software updates, signal transmission equipment, and video equipment. Provide the manufacturer's required adjustments and all other work necessary.

### 1.6.3 Personnel

Service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

### 1.6.4 Schedule of Work

The Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

- a. Visual checks and operational tests of the CPU, switcher, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
- b. Run system software and correct all diagnosed problems.
- c. Resolve any previous outstanding problems.

### 1.6.5 Emergency Service

The Government will initiate service calls when the CCTV system is not functioning properly. Qualified personnel shall be available to provide service to the complete CCTV system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. The CCTV system shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

### 1.6.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

### 1.6.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices.

The log shall contain calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the CCTV system.

#### 1.6.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is completed.

#### 1.6.9 System Modifications

The Contractor shall make any recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

#### 1.6.10 Software

The Contractor shall recommend all software updates to the Government for approval. Upon Government approval, updates shall be accomplished in a timely manner, fully coordinated with the CCTV system operators, operation in the system verified, and shall be incorporated into the operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the manufacturer's software.

### PART 2 PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

All system hardware and software components shall be produced by manufacturers regularly engaged in the production of CCTV equipment. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Equipment located at the security center or a remote control/monitoring station shall be rack mounted as shown. Both Television and Computing devices shall comply with 47 CFR 15, Subpart B.

##### 2.1.1 Soldering

All soldering shall be done in accordance with standard industry practices.

#### 2.2 ENCLOSURES

The Contractor shall provide metallic enclosures as needed for equipment not housed in cabinets, consoles or supplied with a housing. The enclosures shall be as specified or shown.

### 2.2.1 Interior

Enclosures to house equipment in an interior environment shall meet the requirements of NEMA 250 Type 12.

### 2.2.2 Exposed-to-Weather

Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250 Type 4X.

### 2.2.3 Corrosion-Resistant

Enclosures to house equipment in a corrosive environment shall meet the requirements of NEMA 250 Type 4X.

### 2.2.4 Consoles

All system components except cameras shall be mounted in floor munted consoles as indicated.

## 2.3 TAMPER PROVISIONS

Enclosures, cabinets, housings (other than environmental camera housings), boxes, raceways, conduits, and fittings of every description having hinged doors or removable covers, and which contain any part of the CCTV equipment or power supplies, shall be provided with cover operated, corrosion-resistant tamper switches, arranged to initiate an alarm signal when the door or cover is moved. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. The enclosure and the tamper switch shall function together to not allow direct line of sight to any internal components and tampering with the switch or the circuits before the switch activates. Tamper switches shall be inaccessible until the switch is activated; have mounting hardware concealed so that the location of the switch cannot be observed from the exterior of the enclosure; be connected to circuits which are under electrical supervision at all times, irrespective of the protection mode in which the circuit is operating; shall be spring-loaded and held in the closed position by the door cover; and shall be wired so that they break the circuit when the door or cover is disturbed. Tamper switches on the doors which must be opened to make routine maintenance adjustments to the system and to service the power supplies shall be push/pull-set, automatic reset type.

### 2.3.1 Enclosure Covers

Covers of pull and junction boxes provided to facilitate installation of the system need not be provided with tamper switches if they contain no splices or connections, but shall be protected by tack welding or brazing the covers in place. Zinc labels shall be affixed to such boxes indicating they contain no connections. These labels shall not indicate that the box is part of the security system.

### 2.3.2 Conduit-Enclosure Connections

All conduit-enclosure connections shall be protected by tack welding or brazing the conduit to the enclosure. Tack welding or brazing shall be done in addition to standard conduit-enclosure connection methods as described in NFPA 70.

## 2.4 LOCKS AND KEY-LOCK OPERATED SWITCHES

### 2.4.1 Locks

Locks shall be provided on system enclosures for maintenance purposes shall be UL listed, round-key type, with three dual, one mushroom, and three plain pin tumblers. Keys shall be stamped "U.S. GOVT. DO NOT DUP." The locks shall be so arranged that the key can only be withdrawn when in the locked position. All maintenance locks shall be keyed alike and only two keys shall be furnished for all of these locks.

### 2.4.2 Key-Lock-Operated Switches

All key-lock-operated switches required to be installed on system components shall be UL listed, with three dual, one mushroom, and three plain pin tumblers, or conventional key type lock having a combination of five cylinder pin and five-point three position side bar. Keys shall be stamped "U.S. GOVT. DO NOT DUP." Key-lock-operated switches shall be two position, with the key removable in either position. All key-lock-operated switches shall be keyed differently and only two keys shall be furnished for each key-lock-operated-switch.

## 2.5 SYSTEM INTEGRATION

The CCTV system shall be interfaced to the ESS and shall provide automatic, alarm actuated call-up of the camera associated with the alarm zone. Equipment shall be supplied with all adapters, terminators, cables, main frames, card cages, power supplies, rack mounts, and appurtenances as needed.

## 2.6 SOLID STATE CAMERAS

### 2.6.1 High Resolution Color Camera

All electronic components and circuits shall be solid state. Signal-to-noise ratio shall not be less than 50 dB unweighted. The camera shall exhibit no geometric distortion. The lens mount shall be a C-mount, and the camera shall have a back focus adjustment. The camera shall operate from 14 to 131 degrees F without auxiliary heating or cooling, and with no change in picture quality or resolution. The camera shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 24 Volts. Provide with remote zoom feature.

#### 2.6.1.1 Solid State Image Array

The camera shall have a solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA 330. The camera shall provide not less than 460 lines of horizontal resolution, and resolution shall not vary over the life of the camera. The imager shall have at least 768 horizontal x 494 vertical active picture elements.

#### 2.6.1.2 Sensitivity

Camera shall provide full video output with the infrared cut-off filter installed, without camera automatic gain, and a scene reflectivity of 75 percent using an f/1.2 lens given a camera faceplate illumination at 3200K of 0.2 footcandle minimum.

### 2.6.1.3 Camera Synchronization

The camera shall have an input for external sync, and shall automatically switch over to internal sync if external sync is not present. The camera shall also have the capability of synchronization by line-locking to the AC power line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.

### 2.6.1.4 Connectors

Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions. Video signal output connector shall be a BNC. Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors. A connector shall be provided for external sync input.

### 2.6.1.5 Automatic Circuits

The camera shall have circuitry for through the lens (TTL) white balancing, fixed white balancing, and automatic gain control.

## 2.6.2 Dome Cameras

### 2.6.2.1 Interior Dome Camera System

An interior dome camera system shall be provided with integral camera installed and integrated into the dome housing. The camera shall meet the requirements of Paragraph: High Resolution Color Camera as specified. The dome housing shall be nominally 6 inches and shall be furnished in a pendant mount or ceiling mount as shown. The lower dome shall be tinted acrylic and shall have a light attenuation factor of not more than 1 f-stop. The housing shall be equipped with integral pan/tilt complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt shall have heavy duty bearings and hardened steel gears. The pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second. There shall not be less than 64 preset positions, with positioning speeds of at least 360 degrees per second in the automatic mode, and not less than 120 degrees per second in the manual positioning mode, with a positioning accuracy of plus or minus 1/2 degree. Each set of preset position data shall include auto focus, auto iris, pan, tilt, and zoom functions. The system shall be able to automatically scan between any two electronically-set limits, and shall be able to operate in the "tour" mode covering up to all presets in a user defined sequence. The dome system shall withstand temperature ranges from minus 22 to 122 degrees F over a humidity range of 0 to 90 percent, non-condensing.

### 2.6.2.2 Exterior Dome Camera System

An exterior dome camera system shall be provided with integral camera installed and integrated into the dome housing. The camera shall have a minimum horizontal resolution of 425 lines (color) or 500 lines (monochrome). The dome housing shall be nominally 6 inches and shall be furnished in a NEMA 4 pendant mount, pole mount, ceiling mount, surface

mount, or corner mount as shown. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall protect the internal drives, positioners, and camera from the environment encountered for camera operation. The lower dome shall be tinted acrylic and shall have a light attenuation factor of not more than 1 f-stop. An integral heater, sized to maintain the lower dome above the dew point, shall be part of the camera system. The housing shall be equipped with integral pan/tilt complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt shall have heavy duty bearings and hardened steel gears. The pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second. There shall not be less than 99 preset positions, with positioning speeds of at least 360 degrees per second in the automatic mode, and not less than 120 degrees per second in the manual positioning mode, with a positioning accuracy of plus or minus 1/2 degree. Each set of preset position data shall include auto focus, auto iris, pan, tilt, and zoom functions. The system shall be able to automatically scan between any two electronically-set limits, and shall be able to operate in the "tour" mode covering up to all presets in a user defined sequence. The dome system shall withstand temperature ranges from minus 40 to 122 degrees F over a humidity range of 0 to 90 percent, non-condensing. Provide with remote zoom feature.

## 2.7 CAMERA LENSES

Camera lenses shall be all glass with coated optics. The lens mount shall be a C or CS mount, compatible with the cameras selected. The lens shall be supplied with the camera, and shall have a maximum f-stop opening of f/1.2 or the maximum available for the focal length specified. The lens shall be equipped with an auto-iris mechanism unless otherwise specified. Lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors, wiring, receiver/drivers, and controls as needed to operate the lens functions. Lenses shall have sufficient circle of illumination to cover the image sensor evenly. Lenses shall not be used on a camera with an image format larger than the lens is designed to cover. Lens focal lengths shall be as shown or specified in the manufacturer's lens selection tables. Provide with remote zoom feature.

## 2.8 CAMERA HOUSINGS AND MOUNTS

The camera and lens shall be enclosed in a tamper resistant housing as specified below. Any ancillary housing mounting hardware needed to install the housing at the camera location shall be provided as part of the housing. The camera and lens contained in a camera housing shall be installed on a camera support. Any ancillary mounting hardware needed to install the support and to install the camera on the support shall be provided as part of the support. The camera support shall be capable of supporting the equipment to be mounted on it including wind and ice loading normally encountered at the site.

### 2.8.1 Environmentally Sealed Camera Housing

The housing shall be designed to provide a condensation free environment for camera operation. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be purged of atmospheric air and pressurized with dry nitrogen, shall be equipped with a fill valve, overpressure valve, and shall have a humidity indicator visible from the exterior. Housing shall not have a leak rate greater than 2 pounds per square inch at sea level within a 90 day period. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall provide the environment needed for camera operation, and shall keep the viewing window free of fog, snow, and ice. The housing shall be equipped with a sunshield, and both the housing and the sunshield shall be white. A mounting bracket which can be adjusted to center the weight of the housing and camera assembly shall be provided as part of the housing.

### 2.8.2 Interior Dome Housing

An interior dome housing shall be provided for each camera as shown. The dome housing shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mount as shown. The lower dome shall be black opaque acrylic and shall have a light attenuation factor of not more than 1 f-stop. The housing shall be equipped with integral pan/tilt/zoom complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt/zoom shall have heavy duty bearings and hardened steel gears. The pan/tilt/zoom shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360 degrees and tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second.

### 2.8.3 Exterior Dome Housing

An exterior dome housing shall be provided for each camera. The dome housing shall be a pendant mount, ceiling mount, surface mount, or corner mount as shown. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be purged of atmospheric air and pressurized with dry nitrogen, shall be equipped with a fill valve and overpressure valve, and shall have a pressure indicator visible from the exterior. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall provide the environment needed for camera operation. The lower dome shall be black opaque acrylic and shall have a light attenuation factor of not more than 1 f-stop. The housing shall be equipped with integral pan/tilt complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt dome. The pan/tilt shall have heavy duty bearings and hardened steel gears. The pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall be 360

degrees and tilt movement shall not be less than plus and minus 90 degrees.

Pan speed shall not be less than 20 degrees per second, and tilt speed shall not be less than 10 degrees per second.

#### 2.8.4 Exterior Wall Mount

Where an exterior camera is wall mounted, the exterior camera wall mount shall be 16 inches long, and shall have an adjustable head for mounting the camera. The wall mount and head shall be constructed of aluminum, stainless steel, or steel with a corrosion-resistant finish. The head shall be adjustable for not less than plus and minus 90 degrees of pan, and not less than plus and minus 45 degrees of tilt. If the bracket is to be used in conjunction with a pan/tilt, the bracket shall be supplied without the adjustable mounting head, and shall have a bolt hole pattern to match the pan/tilt base.

#### 2.8.5 Pan/Tilt Mount

The pan/tilt mount shall be capable of supporting the camera, lens and housing specified. If the pan/tilt is to be mounted outdoors, the pan/tilt shall be weatherproof, and sized to accommodate the camera, lens and housing weight plus maximum wind loading encountered at the installation site. The pan/tilt shall have heavy duty bearings, hardened steel gears, externally adjustable limit stops for pan and tilt, and mechanical, dynamic or friction brakes. Pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall not be less than 0 to 350 degrees, tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 6 degrees per second, and tilt speed shall not be less than 3 degrees per second. The pan/tilt shall be supplied complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt mount to fulfill the site design requirements.

### 2.9 VIDEO MONITOR

#### 2.9.1 [Enter Appropriate Subpart Title Here] 2.9.2 Color Video Monitor

All electronic components and circuits shall be solid state except for the picture tube. The monitor shall have a stabilized high voltage power supply, and regulated low voltage power supplies. The monitor shall have automatic frequency control (AFC) and horizontal resolution not less than 280 lines at the center of the picture tube. The video input shall allow switchable loop-through or 75 ohm termination. The monitor shall have circuitry for automatic degaussing. The monitor shall operate on 60 Hz AC power, and shall be capable of operating at a voltage of 105 to 130 Volts.

#### 2.9.3 Picture Tube

The monitor shall have a picture tube dimension as indicated, measured diagonally.

#### 2.9.4 Configuration

The monitor shall be configured in a console mount. The mount shall fit in a standard EIA 19 inch rack as described in EIA ANSI/EIA-310-D. Monitors shall not interfere with each other when console mounted or operated next to each other as described in EIA ANSI/EIA-375-A-1976.

### 2.9.5 Controls

Front panel controls shall be provided for power on/off, horizontal hold, vertical hold, contrast, and brightness. The monitor shall have switchable DC restoration.

### 2.9.6 Connectors for Video Monitor

Video signal input and output shall be by BNC connectors.

## 2.10 VIDEO SWITCHER

The switcher shall conform to EIA 170 specifications, and shall be a vertical interval switcher. Electronic components, subassemblies, and circuits of the switcher shall be solid state. The switcher shall be microprocessor based and software programmable. The switcher shall be a modular system that shall allow for expansion or modification of inputs, outputs, alarm interfaces, and secondary control stations by addition of the appropriate modules. Switcher components shall operate on 120 volts 60 Hz AC power. The switcher central processor unit shall be capable of being interfaced to a master security computer for integrated operation and control. The video switcher central processing unit (CPU) shall have the capability of accepting time from a master clock supplied in ASCII format through an EIA ANSI/EIA/TIA-232-F input. All components, modules, cables, power supplies, software, and other items needed for a complete and operable CCTV switching system shall be provided. Switcher equipment shall be rack mounted unless otherwise specified. Rack mount hardware shall be supplied to mount the switcher components in a standard 19 inch rack as described in EIA ANSI/EIA-310-D.

### 2.10.1 Switcher Software

The switcher shall be software programmable, and the software shall be supplied as part of the switcher. The software shall be installed in the switcher CPU, and shall be configured as required by the site design. Changes or alterations of features under software control shall be accomplished through software programming without changes in hardware or system configuration. The switcher shall retain the current program for at least 6 hours in the event of power loss, and shall not require reprogramming in order to restart the system.

### 2.10.2 Switcher Matrix

The switcher shall be a programmable crosspoint switcher capable of switching any video input to any video output. The switcher to be installed at the site shall be configured to switch all cameras to two or more monitors, and shall have an expansion capability of not less than 10 percent.

### 2.10.3 Switcher Modular Expansion

The switcher shall be expandable in minimum increments as specified below.

#### 2.10.3.1 Input Module

Hardware expansion modules shall be provided to expand the switcher matrix configuration in increments of at least 8 camera inputs.

#### 2.10.3.2 Output Module

Hardware expansion modules shall be provided to expand the switcher matrix configuration in increments of at least 4 video outputs.

#### 2.10.4 Alarm Interface

An alarm interface shall be furnished with the switcher. The interface shall be compatible with the ESS alarm annunciation system. The alarm interface shall monitor alarm closures for processing by the switcher CPU. Alarm inputs to the alarm interface shall be relay contact or through an EIA ANSI/EIA/TIA-232-F interface. The alarm interface shall be modular and shall allow for system expansion. The alarm interface to be installed at the site shall be configured to handle 10 alarm points, and shall have an expansion capability of not less than 10percent. An output shall be provided to actuate a video recorder.

#### 2.10.5 Switcher Response Time and Alarm Processing

The switcher response time shall not be greater than 200 milliseconds from the time the alarm is sensed at the switcher alarm interface, until the picture is displayed on the monitor. The switcher shall continue to process subsequent alarms and shall put them in a queue. The operator shall be able to view the alarms in queue by operating an alarm release function which switches the subsequent alarms to the monitor in the order of occurrence.

#### 2.10.6 Control Keyboards

Control and programming keyboards shall be supplied for the video switcher at the security center, and control keyboards shall be supplied for any control/monitoring stations as shown. The control keyboard shall provide the interface between the operator and the CCTV system, and shall relay commands from the operator to the switcher CPU. The keyboard shall provide control of the video switcher functions needed for operation and programming of the video switcher. Controls shall include, but not be limited to: programming the switcher, switcher control, lens function control, pan/tilt/zoom (PTZ) control, control of environmental housing accessories, and annotation programming. If the switcher CPU requires an additional text keyboard for system management functions, the keyboard shall be supplied as part of the video switcher.

#### 2.10.7 Accessory Control Equipment

The video switcher shall be equipped with signal distribution units, preposition cards, expansion units, cables, software or any other equipment needed to ensure that the CCTV system is complete and fully operational.

#### 2.10.8 Connectors for Video Switcher

Video signal input and output shall be by BNC connectors.

#### 2.10.9 Video Annotation

Video annotation equipment shall be provided for the video switcher. The annotation shall be alphanumeric and programmable for each video source. Annotation to be generated shall include, but not be limited to: individual video source identification number, time (hour, minute, second) in a 24 hour format, date (month, day, year), and a unique, user-defined title with

at least 8 characters. The annotation shall be inserted onto the source video so that both shall appear on a monitor or recording. The lines of annotation shall be movable for horizontal and vertical placement on the video picture. The annotation shall be automatically adjusted for date. Programmed annotation information shall be retained in memory for at least 4 hours in the event of power loss.

## 2.11 VIDEO MULTIPLEXER

The video multiplexer shall be a multi-channel record and playback system with the capability of monochrome and color real time multi-screen viewing.

Electronic components, sub assemblies, and circuits of the multiplexer shall be solid state. The multiplexer, using time division multiplexing, shall permit up to 16 camera inputs to be recorded simultaneously on a single video cassette recorder (VCR) and digital recording. All 16 camera inputs shall be capable of being viewed on a video monitor either live or recorded. The multiplexer shall allow for viewing of either live video or input from the VCR (Simplex Operation) The multiplexer shall allow for simultaneous viewing, recording playback, and multiplexing (Duplex Operation). The inputs shall be capable of simultaneous viewing on the monitor or full screen individually and in other multi-screen modes such as 2x2, 3x3, 4x4 or other configurations. The viewing format shall also permit 2x dynamic zoom capability, full screen. The multiplexer shall be compatible with EIA/NTSC video cameras and standard or super VHS VCRs. External camera synchronization shall not be required for proper operation of the video multiplexer. Control of all functions of the multiplexer shall be provided either by a full function keyboard or by pushbutton selection with on-screen menu driven set-up. The multiplexer shall retain the current program for at least 6 hours in the event of power loss.

## 2.12 VIDEO CASSETTE RECORDER (VCR)

VCR shall conform to EIA 170 standards. The VCR shall be specifically designed as a time lapse recorder for use in security systems. The VCR shall operate on 120 volts 60 Hz AC power. Resolution of the VCR in normal play mode shall not be less than 350 horizontal lines in monochrome, 300 horizontal lines in color. Signal-to-noise ratio shall not be less than 40 dB. The VCR shall have a condensation or dew circuit. The VCR shall have a built-in time and date generator that can be turned on or off, and shall impose the time and date on the video during recording. A 24 hour battery back-up shall be provided to protect time/date and programmed information. The VCR shall have an audible warning alarm that shall annunciate the end of tape, excessive condensation, tape transport malfunction, or tape jam.

### 2.12.1 Tape and Tape Transport

The video tape used in the recorder shall be contained in a cassette mechanism, and shall not require the operator to thread the tape through the tape transport mechanism. The tape shall load through the front of the recorder.

### 2.12.2 Recording and Playback

The VCR shall be capable of recording for 168 hours or more on a single cassette tape with at least 6 user selectable time-lapse record speeds. The VCR shall have a contact closure alarm signal input which shall automatically switch the recorder into standard play, record mode when an alarm is initiated. The recorder shall reach stabilized record speed in 1 second or less. The VCR shall put a cue mark on the tape at the beginning

of an alarm event recording. The alarm event record time shall be selectable for up to 3 minutes of automatic recording as a minimum. A record-lock feature shall be provided which shall protect the VCR against tampering with the tape transport controls and power control once recording has started. Playback functions shall include: alarm search, fast forward search, fast rewind search, rewind/fast forward, play, slow motion or step field/frame, and pause/still.

#### 2.12.3 Connectors for VCR

Video signal input and output shall be by BNC connectors. The recorder shall provide connectors for alarm trigger signal input and output.

### 2.13 VIDEO SIGNAL EQUIPMENT

The following video signal equipment shall conform to EIA 170. Electrically powered equipment shall operate on 120 Volts 60 Hz AC power. All video signal inputs and outputs shall be by BNC connectors.

#### 2.13.1 Ground Loop Corrector

The ground loop corrector shall eliminate the measured ground loop interference (common mode voltage) in wireline or coaxial video transmission lines. The ground loop corrector shall pass the full transmitted video bandwidth with no signal attenuation or loss. Clamping ground loop correctors shall be capable of rejecting at least an 8 volt peak-to-peak 60 Hz common mode signal. Ground isolation transformers shall be capable of rejecting at least a 10 volt peak-to-peak 60 Hz common mode signal. Ground isolation amplifiers shall be capable of rejecting at least a 30 volt peak-to-peak 60 Hz common mode signal. Differential ground loop correctors shall be capable of rejecting at least a 100 volt peak-to-peak 60 Hz common mode signal.

#### 2.13.2 Video Loss/Presence Detector

The video loss/presence detector shall monitor video transmission lines for presence of the video signal. The detector shall annunciate an alarm when the video signal drops below a pre-set threshold level. A threshold level adjustment shall be provided for each video channel, and the threshold level shall be continuously adjustable through a lockable front panel control. A front panel reset control shall be provided for each video channel, which shall reset the detector after an alarm. The video loss alarm shall be annunciated through a front panel LED and a contact closure as a minimum. Video input shall be loop-through, and the video shall be unaffected when the detector is turned off. The detector shall not attenuate or reduce the level of the video signal passing through it.

#### 2.13.3 Video Equalizing Amplifier

The video equalizing amplifier shall be designed to correct loss in video signal level and high frequency attenuation caused by long distance video signal transmission over wireline DTM. The amplifier shall have independent signal gain and equalization controls. The amplifier shall be capable of equalizing at least 3000 feet of RG-11/U coaxial cable conforming to paragraph CCTV Equipment Video Signal Wiring. The amplifier shall provide a minimum of plus or minus 6 dB of video gain and 12 dB of high frequency compensation. At least one video output shall be provided for each video input. Bandwidth shall be 10 MHz or greater, and frequency response to 8 MHz shall be plus or minus 1 dB or less. Hum and noise shall

be 50 dB below 1 volt peak-to-peak or better. Video inputs shall be 75 ohm unbalanced, terminating, differential grounded. Video outputs shall be 75 ohm, differential, source terminated, 1 volt peak-to-peak. Output isolation shall be 40 dB or greater at 5 MHz.

#### 2.13.4 Video Distribution Amplifier

The video distribution amplifier shall be designed to distribute a single, 75 ohm, unbalanced video input signal to a minimum of 4, 75 ohm, source terminated video outputs. The distribution amplifier shall have not less than plus or minus 3 dB of gain adjustment for the video output. Output isolation shall be 40 dB or greater at 5 MHz. Bandwidth shall be 10 MHz or greater, and frequency response to 8 MHz shall be plus or minus 0.5 dB or less. Hum and noise shall be 55 dB below 1 volt peak-to-peak or better.

#### 2.13.5 Master Video Sync Generator

The master video sync generator shall generate horizontal drive, vertical drive, blanking, and sync signals as a minimum, with at least one 75 ohm output provided for each signal. The master oscillator crystal shall be pre-aged, and temperature stabilized, ovenized or temperature compensated. The sync generator shall have a composite video input and shall lock to the incoming video signal. If no video is present at the video input, the sync generator shall switch to internal crystal control. Not less than 2.5 microseconds advance and 2.5 microseconds delay of horizontal phase shall be provided. Vertical blanking width adjustment shall be provided. Vertical blanking width adjustment shall have a minimum selection range of 19, 20, and 21 lines.

#### 2.13.6 Video Sync Distribution Amplifier

The sync distribution amplifier shall be a regenerative amplifier designed to distribute a sync signal input to not less than 6, 75 ohm outputs. Output level shall remain constant and shall not be affected by input level variations. Output isolation shall be greater than 35 dB at 5 MHz. A high impedance loop through shall be provided in addition to the 6 outputs. The distribution amplifier shall have continuously variable delay range of at least 250 nanoseconds to 2.2 microseconds. The delay shall be adjustable through a front panel control.

### 2.14 ACCESSORIES

Standard 19 inch electronic rack consoles conforming to EIA ANSI/EIA-310-D shall be provided for the CCTV system at the local security center and remote control/monitoring site (main entrance control point room).

### 2.15 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government Furnished Equipment. All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.

#### 2.15.1 CCTV Equipment Video Signal Wiring

The coaxial cable shall have a characteristic impedance of 75 ohms plus or minus 3 ohms. RG 59/U coaxial signal cable shall have shielding which provides a minimum of 95 percent coverage, a solid copper center conductor of not less than 23 AWG, polyethylene insulation, and a black

non-contaminating polyvinylchloride (PVC) jacket. RG 6/U coaxial cable shall have shielding which provides a minimum of 95 percent coverage, with center conductor of 18 AWG or larger polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket.

#### 2.15.2 Low Voltage Control Wiring

Twisted pair low voltage control wiring to be provided. Plenum or riser cables shall be IEEE C2 CL2P certified.

#### 2.15.3 Digital Data Interconnection Wiring

Interconnecting cables carrying digital data between equipment located at the security center or at a secondary control/monitoring site shall be not less than 20 AWG and shall be stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100 percent coverage. Cables with a single overall shield shall have a tinned copper shield drain wire. Plenum or riser cables shall be IEEE C2 CL2P certified.

### 2.16 PREDELIVERY TESTING

#### 2.16.1 General

The Contractor shall assemble the test CCTV system as specified, and perform tests to demonstrate that the performance of the system complies with the contract requirements in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during predelivery testing, including results of each test procedure, shall be delivered to the Government at the conclusion of predelivery testing prior to Government approval of the test. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.

#### 2.16.2 Test Setup

The Contractor shall provide the equipment needed for the test setup and shall configure it to provide alarm actuated camera call-up and alarm recording as required to emulate the installed system. The test setup shall consist of at least 4 complete camera circuits. The alarm signal input to the CCTV test setup shall be by the same method that is used in the installed system. The video switcher shall be capable of switching any camera to any monitor and any combination of cameras to any combination of monitors. The minimum test setup shall include:

- a. Four video cameras and lenses, including dome cameras if required for the installed system.
- b. Three video monitors.
- c. Video recorder if it is required for the installed system.
- d. Video switcher including video input modules, video output modules, and control and applications software.
- e. Video multiplexer, if required for the installed system.

- f. Alarm input panel if required for the installed system.
- g. Pan/tilt mount and pan/tilt controller if the installed system includes cameras on pan/tilt mounts.
- h. Any ancillary equipment associated with a camera circuit such as equalizing amplifiers, video loss/presence detectors, terminators, ground loop correctors, surge protectors or other in-line video devices.
- i. Cabling for all components.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system. Raceways shall be furnished and installed as specified in Section 16415 ELECTRICAL WORK, INTERIOR. DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. All other electrical work shall be as specified in the above sections including grounding to preclude ground loops, noise, and surges from adversely affecting system operation.

##### 3.1.1 Current Site Conditions

The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

##### 3.1.2 Enclosure Penetrations

All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

##### 3.1.3 Cold Galvanizing

All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

##### 3.1.4 Interconnection of Console Video Equipment

The Contractor shall connect signal paths between video equipment with RG-6/U coaxial cable. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted

equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

#### 3.1.5 Cameras

The Contractor shall install the cameras with the proper focal length lens as indicated for each zone; connect power and signal lines to the camera; set cameras with fixed iris lenses to the proper f-stop to give full video level; aim camera to give field of view as needed to cover the alarm zone; aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun; focus the lens to give a sharp picture over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

#### 3.1.6 Monitors

The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power.

#### 3.1.7 Switcher

The Contractor shall install the switcher as shown and according to manufacturer's instructions; connect all subassemblies as specified by the manufacturer and as shown; connect video signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown; connect the switcher CPU and switcher subassemblies to AC power; load all software as specified and required for an operational CCTV system configured for the site requirements, including data bases, operational parameters, and system, command, and application programs; provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test; and program the video annotation for each camera.

#### 3.1.8 Video Recording Equipment

The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

#### 3.1.9 Video Signal Equipment

The Contractor shall install the video signal equipment as specified by the manufacturer and as shown; connect video or signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as required; connect control signal inputs and outputs as required; and connect electrically powered equipment to AC power.

#### 3.1.10 Camera Housings and Mounts

The Contractor shall install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site; connect signal lines and AC power

to mount interfaces; and connect wiring harness to camera.

### 3.2 SYSTEM STARTUP

The Contractor shall not apply power to the CCTV system until the following items have been completed:

- a. CCTV system equipment items and DTM have been set up in accordance with manufacturer's instructions.
- b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
- c. System wiring has been tested and verified as correctly connected as indicated.
- d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.
- e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.
- f. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

### 3.3 SUPPLEMENTAL CONTRACTOR QUALITY CONTROL

The following requirements supplement the contractor quality control requirements specified elsewhere in the contract. The contractor shall provide the services of technical representatives who are thoroughly familiar with all components and installation procedures of the installed IDS; and are approved by the Contracting Officer. These representatives will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance. These representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control. These technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet its contractual requirements.

### 3.4 SITE TESTING

#### 3.4.1 General

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test.

#### 3.4.2 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated system in service, and test the integrated system. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies in the terrain which may cause blind spots. Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Contracting Officer. The tape shall be recorded using the video recorder installed as part of the CCTV system. If a recorder is not part of the CCTV system, the Contractor shall provide the tape in Video Home System (VHS) format. The Contractor shall provide the Government with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

- a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified.
- b. When the system includes remote control/monitoring stations or remote switch panels, verification that the remote devices are functional, communicate with the security center, and perform all functions as specified.
- c. Verification that the switcher is fully functional and that the switcher software has been programmed as needed for the site configuration.
- d. Verification that switcher software is functioning correctly. All software functions shall be exercised.
- e. Verification that video multiplexers are functioning correctly.
- f. Operation of all electrical and mechanical switcher controls and verification that the control performs the designed function.
- g. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.
- h. Verification that all video signals are terminated properly.
- i. Verification that all cameras are aimed and focused properly. The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.
- j. Verification that cameras facing the direction of rising or setting

sun are aimed sufficiently below the horizon so that the camera does not view the sun directly.

- k. If vehicles are used in proximity of the assessment areas, verification of night assessment capabilities and determination if headlights cause blooming or picture degradation.
- l. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.
- m. Verification that the alarm interface to the IDS is functional and that automatic camera call-up is functional with appropriate video annotation for all designated ESS alarm points and cameras.
- n. When pan/tilt mounts are used in the system, verification that the limit stops have been set correctly. Verification of all controls for pan/tilt or zoom mechanisms are operative and that the controls perform the desired function. If preposition controls are used, verification that all home positions have been set correctly, and have been tested for auto home function and correct home position.
- o. When dome camera mounts are used in the system, verify that all preset positions are correct and that the dome also operates correctly in a manual control mode.

The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

#### 3.4.3 Performance Verification Test

The Contractor shall demonstrate that the completed CCTV system complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Government, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. If the CCTV system is being installed in conjunction with an ESS, the CCTV performance verification test shall be run simultaneously with the ESS performance verification test. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

#### 3.4.4 Endurance Test

- a. The Contractor shall demonstrate the specified requirements of the completed system. The endurance test shall be conducted in phases as specified. The endurance test shall not be started until the Government notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training

as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. If the CCTV system is being installed in conjunction with an ESS, the CCTV performance verification test shall be run simultaneously with the ESS performance verification test. The Contractor shall provide one operator to operate the system 24 hours per day, including weekends and holidays, during Phase I and Phase III endurance testing, in addition to any government personnel that may be made available. The Government may terminate testing at any time the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test the Contractor shall verify the operation of each camera. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

- b. Phase I (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during Phase I testing, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.
- c. Phase II (Assessment): After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, or may require that Phase I be repeated. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.
- d. Phase III (Testing): The test shall be conducted 24 hours per day for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.
- e. Phase IV (Assessment): After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a

test review meeting at the job site to present the results and recommendations to the Government. The meeting shall not be scheduled earlier than 5 business days after receipt of the report by the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by repeating appropriate portions of the performance verification test. Based on the Contractor's report and the test review meeting, the Government will determine the restart date, and may require that Phase III be repeated. The Contractor shall not commence any required retesting until after receipt of written notification by Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

f. Exclusions: The Contractor will not be held responsible for failures resulting from the following:

(1) An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished.

(2) Failure of a Government furnished DTM circuit, provided that the failure was not due to Contractor furnished equipment, installation, or software.

(3) Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

-- End of Section --

## SECTION 16770

## PUBLIC ADDRESS SYSTEMS

04/02

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

## 1.2 SYSTEM DESCRIPTION

The radio and public address system shall consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation. Provide a PA cabinet with a smoked glass front cabinet, type same as the LAN cabinets. See details on the drawings and in communications specifications. Mount controls, preamplifier mixer, power amplifier, AM/FM tuner, compact disc recorder/player, cassette recorder/player, etc., in the PA cabinet.

## 1.2.1 Multi-Channel System with Paging

The system shall include microphones, microphone outlet receptacles, microphone inputs with preamplifiers, inputs for compact disc, magnetic tape, telephone, and program sources, single channel paging, control for each input, power amplifying equipment, and accessories required to output the public address and paging audio signals through selected portions of the audio distribution network as indicated. The paging signal shall replace by zones all channels of the radio system output, when the paging function is activated.

## 1.2.2 Single-Channel System

The system shall control and amplify an audio program for distribution within the areas indicated. Components of the system shall include a mixer-preamplifier, mixer-amplifier, mike input expander, power amplifier, microphone, speaker system, compact disc, cassette player, AM-FM tuner, cabling and other associated hardware.

## 1.2.3 System Performance

The system shall provide even sound distribution throughout the designated area, plus or minus 3 dB for the 1/1 octave band centered at 4000 Hz. The system shall provide uniform frequency response throughout the designated

area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Contracting Officer. The system shall be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newtons per square meter).

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Radio and Public Address System; G,AE.

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. The Contractor shall check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

#### SD-03 Product Data

Spare Parts;

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

#### SD-06 Test Reports

Approved Test Procedures; G, AO.

Test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; G, AO.

Test reports in booklet form showing all field tests performed to

adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system.

#### SD-07 Certificates

Components; G, AE.

Copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components.

#### SD-10 Operation and Maintenance Data

Radio and Public Address System, Data Package 3; G, AO.

Submit data package in accordance with Section 01781, OPERATION AND MAINTENANCE DATA

### 1.4 DELIVERY AND STORAGE

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

### 1.5 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Material and equipment to be provided shall be the standard products of a manufacturer regularly engaged in the manufacture of such products, and shall essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system shall be commercial designs that comply with the requirements specified. Equipment shall be supported by a service organization that is within 20 miles of the site.

#### 2.1.1 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

#### 2.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalog number, and serial number on a plate secured to the equipment.

### 2.2 MIXER-PREAMPLIFIER

Mixer-preamplifier shall as a minimum conform to the following specifications:

Rated Output:	18 dB
Frequency Response:	Plus or Minus 1 dB, 20 - 20,000 Hz
Distortion:	Less than 0.5 percent, 20 - 20,000 Hz
Signal to noise:	Microphone - 60 dB Aux - 70 dB
Inputs:	5 independent balanced low- impedance transformer-isolated
Input Sensitivity:	Microphone - 0.003 volts Aux - 0.125 volts Magnetic Cartridge - 0.0005 volts
Input Channel Isolation:	80 dB minimum
Tone Controls:	Plus or Minus 10 dB range at 50 and 15,000 Hz
Power Requirement:	110-125 Vac 60 Hz

### 2.3 POWER AMPLIFIERS

Power amplifiers as a minimum conform to the following specifications:

Rated power output:	400 watts RMS
Frequency Response:	Plus or Minus 3 dB, 20-20,000 Hz
Distortion:	Less than 2 percent at RPO, 600-13,000 Hz
Input Impedance:	50 k ohm unbalanced
Output Impedance:	Balanced 4 and 8 ohms
Output voltage:	25 and 70.7 volts
Power Requirement:	110-125 Vac 60 Hz

### 2.4 MICROPHONE INPUT MODULES

Microphone input modules shall as a minimum conform to the following specifications:

Rated Outputs:	0.25 volts into 10,000 ohms 1.0 volts into 10,000 ohms
Frequency Response:	Plus or Minus 2 dB, 20 - 20,000 Hz
Distortion:	Less than 0.5 percent 20 - 20,000 Hz

Inputs: 4 transformer - coupled balanced 150 ohm  
Input Sensitivity: 0.003 volts  
Input Channel  
Isolation: 70 dB minimum

## 2.5 MICROPHONES

### 2.5.1 Desk Microphone

Microphones shall as a minimum conform to the following specifications:

Element: Dynamic  
Pattern: Cardioid  
Frequency Response: 50 - 12,000 Hz  
Impedance: Low impedance mic (150-400 ohms)  
Front-to-back Ratio: 20 dB  
Selector switches: Selector switches for zone shall be  
be Separate  
console adjacent to microphone

### 2.5.2 Microphone Jack

Each outlet for microphones shall consist of a standard outlet box, flush-mounted, and fitted with a three-pole, polarized, locking-type, female microphone jack and a corrosion resistant-steel device plate.

## 2.6 LOUDSPEAKERS

### 2.6.1 Cone Speaker

The cone speaker shall as a minimum conform to the following specifications:

Application: Ceiling  
Frequency range: 60 to 12,000 Hz  
Power Rating: Normal - 7 watts  
Peak - 10 watts  
Voice Coil Impedance: 8 ohms  
Line Matching  
Transformer Type: 25/ 70.7 volt line  
Capacity: 4 watts  
Magnet: 10 ounces or greater  
Primary Taps: 0.5, 1, 2 and 4 watts

Primary Impedance: 25 volts - 1250, 625, and 312 ohms  
70.7 volts - 10k, 5k, and 2.5k ohms

Frequency Response: 30 - 20,000 Hz

Insertion Loss: Less than 1 dB

## 2.6.2 Ceiling Speaker Enclosures

Ceiling speaker enclosure shall be constructed of heavy gauge cold steel with interior undercoating and 1 1/2 inch thick high density fiberglass 1-1/2 lbs per cu. ft. The unit shall be round and designed for recessed installations which will be accomplished via standard screw torsion spring flange mount mounting. Recessed models shall have a rust-preventive, textured white coating and the surface mount unit finished in textured white. Enclosure shall include four triple compound conduit knockouts.

## 2.7 SPEAKER SWITCHING PANEL

### 2.7.1 Selector Switches

Zone control shall be provided for the paging function. The speaker switching panel shall contain at double-pole, push button selector switches and shall be rack-mounted to activate priority relays. Selector switches labeling shall be provided to identify the zones.

### 2.7.2 System Power supply

Power supply shall be provided for priority relays and controls, rack-mounted and sized for a capacity equal to 200 percent of the as-built control system, and shall operate at 24 Vdc. Input and output shall be protected to permit Class 2 wiring in accordance with NFPA 70.

## 2.8 AM/FM EQUIPMENT

### 2.8.1 AM/FM Tuner

AM/FM tuner shall be rack-mounted and shall as a minimum conform to the following characteristics:

Tuning Range: AM - 540 to 1605 kHz  
FM - 88 to 108 MHz

Selectivity: 60 dB on FM  
40 dB on AM

Sensitivity: FM - 1.5 microvolts  
AM - 2.0 microvolts

Capture Ratio: 1.0 dB

Readout/selection: Digital

Other features: Phased Lock Loop (PLL)

Power Requirement: 110-125 Vac, 60Hz

### 2.8.2 AM/FM Antenna

The AM/FM antenna shall be roof-mounted, either combined and suitable for both AM and FM reception or separate AM and FM antennas and shall cover all frequency bands specified for radio tuners. The antenna system shall be coordinated with the TV system and other systems with antenna communication.

The system shall be furnished complete with a transformer, insulators, crossover insulator, cable of proper length, lightning arresters, coupling transformer and divider network at the radio tuners.

## 2.9 COMPACT DISC PLAYER

Player shall have three beam laser pickup, dual Digital-to-Analog converters, random access and random mode programmable playback. Player shall have capability to play a minimum of 5 discs automatically. Player shall as a minimum conform to the following:

Frequency:	10 - 20,000 Hz Plus or Minus 1 dB
Signal-to-Noise:	Minimum of 100 dB
Dynamic Range:	Minimum of 96 dB
Total Harmonic Distortion:	Maximum of 0.005% at 1 KHZ
Channel Separation:	Minimum 100 dB at 1 KHZ
Quantization:	Minimum of 18 Bits Linear per channel
Conversion Rate:	Minimum 8 x Oversampling
Disc Size:	5 inch
Power Requirement:	110-125 Vac, 60Hz

## 2.10 CASSETTE TAPE EQUIPMENT

The cassette tape play deck shall as a minimum conform to the following specifications:

Frequency Response:	Plus or minus 3 dB, 20 - 20,000 Hz
Wow and Flutter:	Less than 0.09 percent WRMS
Signal-to-Noise:	74 dB
Noise Reduction system:	Dolby B
Play Head:	Hard Parmalloy
Operation:	Automatic Reverse
Power Requirement:	110-125 Vac, 60 Hz

## 2.11 PRIORITY RELAYS AND CONTROLS

Priority relays and controls required to accomplish operations specified shall be provided. Relays shall be completely enclosed with a plastic dust cover for maximum protection against foreign matter, and shall be plug-in type. Relays shall be provided with a diode wired across the relay coil

for transient suppression and shall be installed utilizing factory-prewired, rack-mounted receptacle strips. Coil shall be maximum 24 volts dc.

## 2.12 SWITCHES AND CONTROLS

### 2.12.1 Radio System Control Switch

The loudspeaker in each room, or group of speakers in a room, shall be provided with a flush program channel selector rotating-switch knob. The switch shall be mounted at location and height above the floor and in accordance with Section 16415A ELECTRICAL WORK, INTERIOR . A volume control shall be installed with a switch at each station and shall be of the auto transformer type and set so that the maximum volume is sufficient for the area while not disturbing adjacent areas. If music is turned down or off, the paging signal shall override controls except speakers designated for music only. Each device plate shall be satin-finished, corrosion-resisting steel permanently marked to indicate the channel selected.

### 2.12.2 Remote Loudspeaker ON/OFF Switches

Remote switches shall be toggle switch 2-pole, wall-mounted, single gang type with engraved switch plates finished to match the approved finish of electrical wall switches. Low-voltage priority override relays shall be provided as part of the switches with all wiring to the racks to allow override of the ON/OFF switches for priority announcements.

### 2.12.3 Remote Loudspeaker Volume Controls

Remote volume controls shall be an auto transformer type with detented 3 dB steps and an OFF position. The controls shall be wall-mounted in single-gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be 75 watts. Low-voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

## 2.13 EQUIPMENT RACKS

Equipment shall be mounted on 19 inch racks in accordance with EIA ANSI/EIA-310-D and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels shall be provided. Equipment racks shall be provided with lockable front panels that limit access to equipment. The lockable front shall not cover items that require operator access such as am/fm tuner, CD player, or tape player. Rack cooling shall be through perforations or louvers in front panels to ensure adequate ventilation of equipment and top rack mounted fan. The racks and panels shall be factory finished with a uniform baked enamel over rust inhibiting primer.

## 2.14 CABLES

### 2.14.1 Speaker Cable

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic

thermoplastic not less than 0.009 inch. Cables shall be jacketed with a Fluoropolymer compound. The jacket thickness shall be 0.02 inch minimum.

#### 2.14.2 Microphone Cable

Cable conductor shall be stranded copper 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.009 inch. Cable shall be shielded 100% of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables shall be jacketed with a Fluoropolymer compound. The jacket thickness shall be 0.02 inch minimum.

#### 2.14.3 Antenna Cable

Antenna coaxial cable shall have 75 ohm plus or minus 2 ohm. Attenuation of the coaxial cable span between the antenna and amplifier shall not exceed 2.5 dB at 108 MHz.

#### 2.15 TERMINALS

Terminals shall be solderless, tool-crimped pressure type.

#### 2.16 SURGE PROTECTION

##### 2.16.1 Power Line Surge Protection

Major components of the system such as power amplifiers, mixer-preamplifiers, and tuners, shall have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground). Surge protection device shall be UL listed and labeled as having been tested in accordance with UL 1449.

##### 2.16.2 SIGNAL SURGE PROTECTION

Major components of the system shall have internal protection circuits which protects the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors shall have surge protection installed at each point where it exits or enters a building.

#### 2.17 TELEPHONE INTERFACE MODULE

Telephone Interface module shall provide one way all call paging access from telephone to PA system. Paging shall be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier.

Interface module shall produce an alert tone in the associated speakers on activation. Telephone interface module shall as a minimum conform to the following specifications:

Impedance:	600 ohms
Frequency response:	100Hz to 10Khz
70V Input Impedance:	200K ohms
Output level:	400mV rms
Input Power Requirement:	12-24Vdc (from power supply)

Access requirement: Electronic (analog) or IA2 line key (line card required) PABX loop or ground-start trunk port, or dedicated single-line phone.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Equipment shall be installed as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted out-of-doors or subject to inclement conditions shall be weatherproofed. The antenna shall be supported at least 60 inch clear above the roof by means of self-supported or guyed mast.

##### 3.1.1 Equipment Racks

Racks shall be mounted side-by-side and bolted together. Items of the same function shall be grouped together, either vertically or side-by-side. Controls shall be symmetrically arranged in the PA Cabinet. The PA cabinet shall be a smoked glass front cabinet type same as the LAN cabinets. See details on the drawings and in communications specifications.. Mount controls, preamplifier mixer, power amplifier, AM/FM tuner, compact disc recorder/player, cassette recorder/player, etc., in the PA cabinet. Audio input and interconnections shall be made with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies shall utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays shall be accessible at the rear of the equipment rack for maintenance and testing. Each item shall be removable from the rack without disturbing other items or connections. Empty space in equipment racks shall be covered by blank panels so that the entire front of the rack is occupied by panels.

##### 3.1.2 Wiring

Wiring shall be installed in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Section 16415A ELECTRICAL WORK, INTERIOR. Wiring for microphone, grounding, line level, speaker and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated at only one end.

#### 3.2 GROUNDING

All grounding practices shall comply with NFPA 70. The antenna mast shall be separately grounded. Equipment shall be grounded to the serving panelboard ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panelboard ground bus utilizing a #8 conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

#### 3.3 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. The

Contractor shall notify the Contracting Officer 14 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross talk or noise from other links or nondesignated units.

#### 3.4 TRAINING

The Contractor shall conduct a training course for 4 members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of 4 hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to the start of the training course.

-- End of Section --

## SECTION 16783

## COMMUNITY ANTENNA TELEVISION (CATV) SYSTEMS

03/01

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 76.605 (1999) Federal Communications Commission;  
Multichannel Video and Cable Television  
Service; Technical Standards

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE C2 (1997) National Electrical Safety Code  
(ANSI/IEEE)

IEEE C62.41 (1991) Surge Voltages in Low-Voltage AC  
Power Circuits (ANSI/IEEE)

## NATIONAL CABLE TELEVISION ASSOCIATION (NCTA)

NCTA 02 (1989; R 1993) Measurements on Cable  
Television Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

## UNDERWRITERS LABORATORIES INC. (UL)

UL 969 (1995; R 1999) Marking and Labeling Systems

## 1.2 RELATED REQUIREMENTS

Section 16415, "ELECTRICAL WORK, INTERIOR," applies to this section with the additions and modifications specified herein.

## 1.3 DEFINITIONS

## 1.3.1 CATV

Community antenna television (CATV) system, commonly referred to as cable television, is a network of cables, headend, electronic and passive components that process and amplify television (TV) signals for distribution from the headend equipment to the individual television outlets.

## 1.3.2 Headend

The connection point between CATV system equipment and equipment provided

by the local CATV company.

### 1.3.3 Distribution System

Distribution system transports and delivers adequate signals to each receiver. Provides distortion-free signal to TV sets by isolating each receiver from the system and by providing proper amount of signal to each set.

### 1.3.4 Cable

Trunk and feeder cables are low-loss cables used to transport the desired signal from the headend equipment to the communications closet in the area to be served. These cables are used to transport signal from the headend equipment into close proximity to a number of user locations in excess of 200 feet from the headend equipment. Drop cables are used to transport the desired signal used from the headend equipment to the wall outlet.

## 1.4 SYSTEM DESCRIPTION

### 1.4.1 Headend

Contractor shall provide interior equipment up to headend and including the main amplifier located at the interior CATV backboard.

### 1.4.2 Distribution System

Distribution system shall be star topology with each outlet connected to headend equipment with the drop cable.

### 1.4.3 Cable

Provide drop cables to transport the desired signal from the headend equipment to the outlet.

### 1.4.4 System Components

System shall provide high quality TV signals to all outlets with a return path for interactive television and cable modem access. Provide any combination of items specified herein to achieve required performance, subject to approvals, limitations, acceptance test, and other requirements specified herein. System shall include amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system.

#### 1.4.4.1 System Bandwidth

- a. Downstream: 50-750 MHz minimum.
- b. Upstream 5-40 MHz minimum.

### 1.4.5 System Performance

System shall be in compliance with 47 CFR 76.605.

#### 1.4.5.1 Receiver Termination Signal Level

Each termination for a TV receiver must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) at 55 MHz and of 0 dBmV (1000

microvolts) at 750 MHz and a maximum signal of 15 dBmV or a level not to overload the receiver for the entire system bandwidth.

#### 1.4.5.2 Distribution System

- a. Modulation distortion at power frequencies: 4 percent or less hum distortion;
- b. Composite third order distortion for:
  - (1) CW carriers: 53 dB.
  - (2) Modulated carriers: 59 dB.
- c. Subscriber terminal isolation: 18 dB or greater.
- d. Carrier to second order beat ratio: 60 dB.
- e. Amplitude characteristic shall be within a range of plus or minus 2 decibels from 0.75 MHz to 5.0 MHz above the lower boundary frequency of the cable television channel, referenced to the average of the highest and lowest amplitudes within these frequency boundaries.
- f. Visual, aural carrier level - 24-hour variation: 47 CFR 76.605, subpart (a), rules (4), (5), and (6).
- g. Frequency determination: 47 CFR 76.605, subpart (a), rules (1),(2), and (3).

#### 1.4.5.3 All New System Tolerance

The system shall not show a serious loss of carrier to noise when the system levels are lowered 3 dB below normal or a significant distortion when the levels are increased 3 dB above normal, as observed on a TV set located at the far end extremities of the system.

#### 1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

CATV system wiring diagrams and installation details; G, AE.

CATV system components; G, AE.

##### SD-03 Product Data

Attenuators;

Amplifiers, including headend, trunk, bridging, and distribution;

Cables, including drop;

Terminators;  
Splitters/combiners;  
Line Taps; G.  
Outlets; G.  
Connectors; G.  
Tilt compensator; G.  
Grounding block; G.

Submittals for each manufactured item shall be the current manufacturer's descriptive literature of catalog products, equipment drawings, diagrams, performance and characteristics curves, and catalog cuts.

#### SD-05 Design Data

CATV System Loss Calculations; G, AE.

#### SD-06 Test Reports

Operational test plan; G.  
Operational test procedures; G.  
System pretest; G.  
Acceptance tests; G.

#### SD-08 Manufacturer's Instructions

Connector Installation; G.

### 1.6 QUALITY ASSURANCE

#### 1.6.1 Wiring Diagrams and Installation Details

Illustrate how each item of equipment functions in the system and include an overall system schematic indicating the relationship of CATV units on one diagram. Drawings shall include wiring diagrams and installation details of equipment indicating proposed locations, layout and arrangements, and other items that must be shown to ensure coordinated installation.

#### 1.6.2 CATV System Loss Calculations

Calculations shall verify that the system does not exceed the loss values specified in dBmV at the receiver terminations. Provide a drawing displaying all distribution network calculations. The drawing should accurately show taps, splitters, outlets, and the type and length of all trunk, feeder, and drop cables. The drawing shall show how many taps, splitters, or outlets are served by each tap or splitter.

#### 1.6.3 Operational Test Plan

Test plan shall define tests required to ensure that the system meets

technical, operational, and performance specifications. Test plan shall be based on NCTA 02 and be in accordance with FCC proof of performance requirements. Test plan shall include plan for testing for signal leakage. Provide test requirements and guidelines.

#### 1.6.4 Operational Test Procedures

Use test plan and design documents to develop test procedures. Procedures shall consist of detailed instructions for a test setup, execution, and evaluation of test results.

#### 1.6.5 Connector Installation

Provide manufacturer's instructions for installing connectors.

### PART 2 PRODUCTS

#### 2.1 ELECTRONIC EQUIPMENT

Electronic components of similar type shall be produced and designed by the same manufacturer as major components of the equipment and shall have the manufacturer's name and model permanently attached. Equipment shall function properly as a complete integrated system. Equipment shall be shielded. The system shall be designed to operate within 5 to 1000 MHz bandwidth using 1000 MHz passive devices and a minimum of 750 MHz active devices.

#### 2.2 HEADEND EQUIPMENT

##### 2.2.1 Headend Amplifiers

Provide broadband distribution amplifiers. Amplifiers shall amplify broadband signals from 40 to 750 MHz and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance. Amplifiers shall be bidirectional with variable slope and gain control.

##### 2.2.2 Attenuators

Provide attenuators to equalize signal levels, when required. Variable attenuators are not permitted.

##### 2.2.3 Power Supplies

Power supplies shall contain a current limiter circuit to protect against short circuits on the radio frequency (RF) line. Provide overvoltage protection to protect solid state equipment from line surges and induced voltages, in accordance with IEEE C62.41.

#### 2.3 DISTRIBUTION EQUIPMENT

##### 2.3.1 Distribution Amplifiers

Distribution amplifiers shall be equipped for 75 ohms input and output impedance. Electronic equipment exposed to weather shall be equipped with weatherproof housings. Amplifiers shall be bidirectional with variable slope and gain control and shall amplify broadband signals from 50 to 750 MHz and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance.

2.3.1.1 [Enter Appropriate Subpart Title Here] 2.3.1.2 [Enter Appropriate

Subpart Title Here]

2.3.2 Cables and Associated Hardware

Cabling shall be UL listed for the application and shall comply with NFPA 70.

Provide a labeling system for cabling as required by UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.2.1 [Enter Appropriate Subpart Title Here] 2.3.2.2 [Enter Appropriate Subpart Title Here]

2.3.2.3 Drop Cable

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of CATVP and with the following characteristics:

- a. No. 18 AWG copper-clad steel center conductor.
- b. Bonded foil inner-shield and 90 percent aluminum braid.
- c. Characteristic impedance of 75 ohms.
- d. Foam FEP dielectric
- e. Nominal capacitance, conductor to shield, of 16.2 pf per 100 ft .
- f. Maximum operating voltage of 350 V RMS.
- g. Maximum attenuation:

CATV

MHz	DB/100 ft	MHz	DB/100 ft
-----	-----------	-----	-----------

CATVP

MHz	DB/100 ft	MHz	DB/100 ft
-----	-----------	-----	-----------

10	0.7	900	6.9
50	1.5	1000	7.3
100	2.1		
200	3.1		
400	4.5		
700	6.0		

- h. PVC low smoke polymer or FEP jacket.
- i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

2.3.3 Terminators

Terminators shall be rated for 75 ohms and 1/4 watt.

2.3.4 Splitters/Combiners

Use splitters/combiners with characteristics equal to or exceeding the characteristics listed in this paragraph over the entire operating band. All unused outlets must be terminated with 75-ohm terminators.

- a. Peak to Valley: Not to exceed 1 dB across bandwidth of device.
- b. Return loss: 18 dB minimum.
- c. Bandwidth: 5-1000 Mhz

#### 2.3.5 Line Taps

Line taps shall have 18 dB minimum isolation from each tap to the thru-line. Pressure tapoffs are not permitted. Taps shall be rated from 5 to 1000 MHz and shall have a peak to valley not to exceed 1 dB to 1 GHz.

#### 2.3.6 Outlets

Provide flush mounted, 75-ohm, F-type connector outlets rated from 5 to 1000 MHz in standard electrical outlet boxes.

#### 2.3.7 Connectors

Provide one piece connectors. Drop cable connectors shall be feed thru type.

#### 2.3.8 Tilt Compensator

Provide tilt compensators as required.

### 2.4 GROUNDING AND BONDING

Provide ground rods and connections in accordance with Section 16402, "Interior Distribution System".

#### 2.4.1 Grounding Block

Provide corrosion-resistant grounding block suitable for indoor installation.

### 2.5 BACKBOARDS

Provide void-free, fire rated interior grade plywood, 3/4 inch thick, 4 by 8 feet. Backboards shall be painted with a gray, nonconductive fire-resistant overcoat. Do not cover the fire stamp on the backboard.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Distribution System

Distribution system shall conform to requirements specified herein. Installation shall be in accordance with IEEE C2 and NFPA 70.

##### 3.1.1.1 Raceway

Provide cable installed in raceways such as conduit in compliance with NFPA 70. Raceway shall comply with Section 16402, "Interior Distribution System." Provide 4 inch, minimum, PVC from interior headend location to exterior CATV company connection location. Coordinate location and requirements with the local cable television company.

##### 3.1.1.2 Grounding System

Provide the grounding block at the main CATV backboard. Ground this device according to the requirements of IEEE C2 and NFPA 70.

### 3.1.1.3 Drop Cable

Provide cable to grounding blocks, to line taps, and to outlets.

## 3.2 FIELD QUALITY CONTROL

### 3.2.1 System Pretest

Upon completing installation of the CATV system, the Contractor shall align and balance the system and shall perform complete pretesting. During the system pretest, Contractor, utilizing the approved spectrum analyzer or signal level meter, shall verify that the system is fully operational and meets all the system performance requirements of the specification.

Contractor shall test the signal loss in dBmV at 55, 151, 547, and 750 MHz. The signal levels shall be 0 dBmV (1000 microvolts), minimum. The signal shall not exceed 15 dBmV over the entire system bandwidth. Any deficiencies found shall be corrected and revalidated by follow up testing.

Contractor shall measure and record the video and audio carrier levels at each of the frequency levels specified at each of the following points in the system:

- a. Furthest outlet from service entrance point of connection.
- b. A random sampling of 25 percent of the outlets.
- c. At each outlet.
- d. Headend and Distribution amplifier inputs and outputs.

### 3.2.2 Acceptance Tests

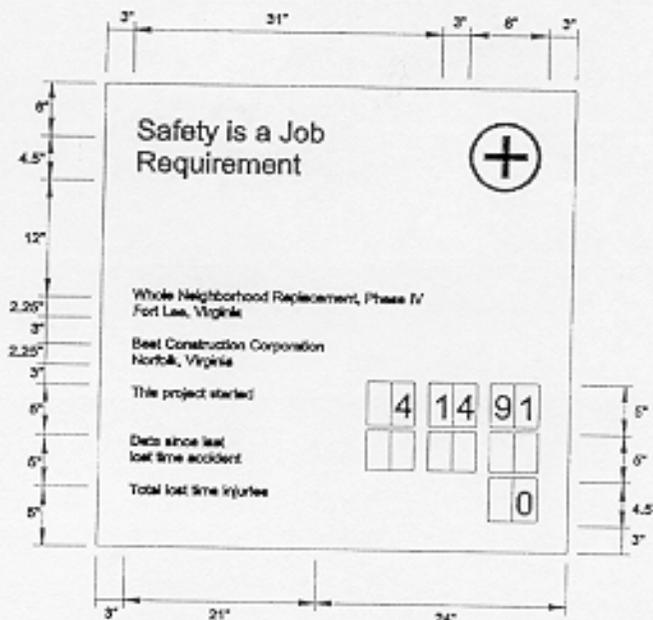
Contractor shall notify the Contracting Officer of system readiness 10 days prior to the date of acceptance testing. Contractor shall also coordinate with the local CATV provider and allow them to attend witness tests. CATV system shall be tested in accordance with the approved test plan in the presence of the Contracting Officer's representative to certify acceptable performance. System test shall verify that the total system meets all the requirements of the specification and complies with the specified standards. Contractor shall verify that no signal leakage exists in conformance with NCTA 02 and 47 CFR 76.605. System leakage shall also be tested at the headend location with signal applied to system.

Deficiencies revealed by the testing shall be corrected on the outlets sampled as well as on the outlets not sampled and revalidated by follow-up testing. Contractor shall conduct testing at each of the following points in the system:

- a. Furthest outlet from service entrance point of connection.
- b. A random sampling of 25 percent of the outlets as designated by the Contracting Officer.
- c. At each outlet.
- d. Headend and Distribution amplifier inputs and outputs.

-- End of Section --

## SAFETY SIGN



All typography is flush left and rag right, upper and lower case with initial capitals only as shown. Letter and word spacing to follow Corps Standards (EP 310-1-6a and 6b).

Legend Group 1: Standard two-line title "Safety is a Job Requirement" with (8" od.) Safety Green First Aid logo. Typeface: 3" Helvetica Bold; Color: Black.

Legend Group 2: One to two-line project title legend describes the work being done under this contract and name of host project. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

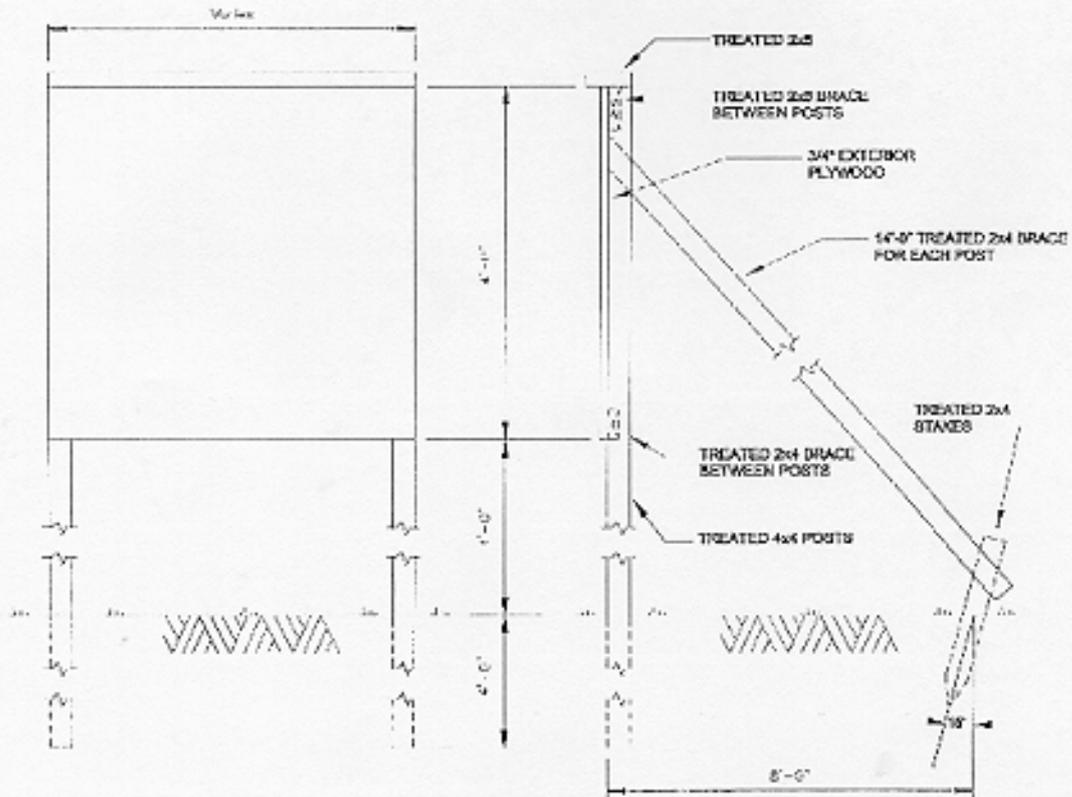
Legend Group 3: One to two-line Identification: name of prime contractor and city, state address. Typeface: 1.5" Helvetica Regular; Color: Black; Maximum line length: 42".

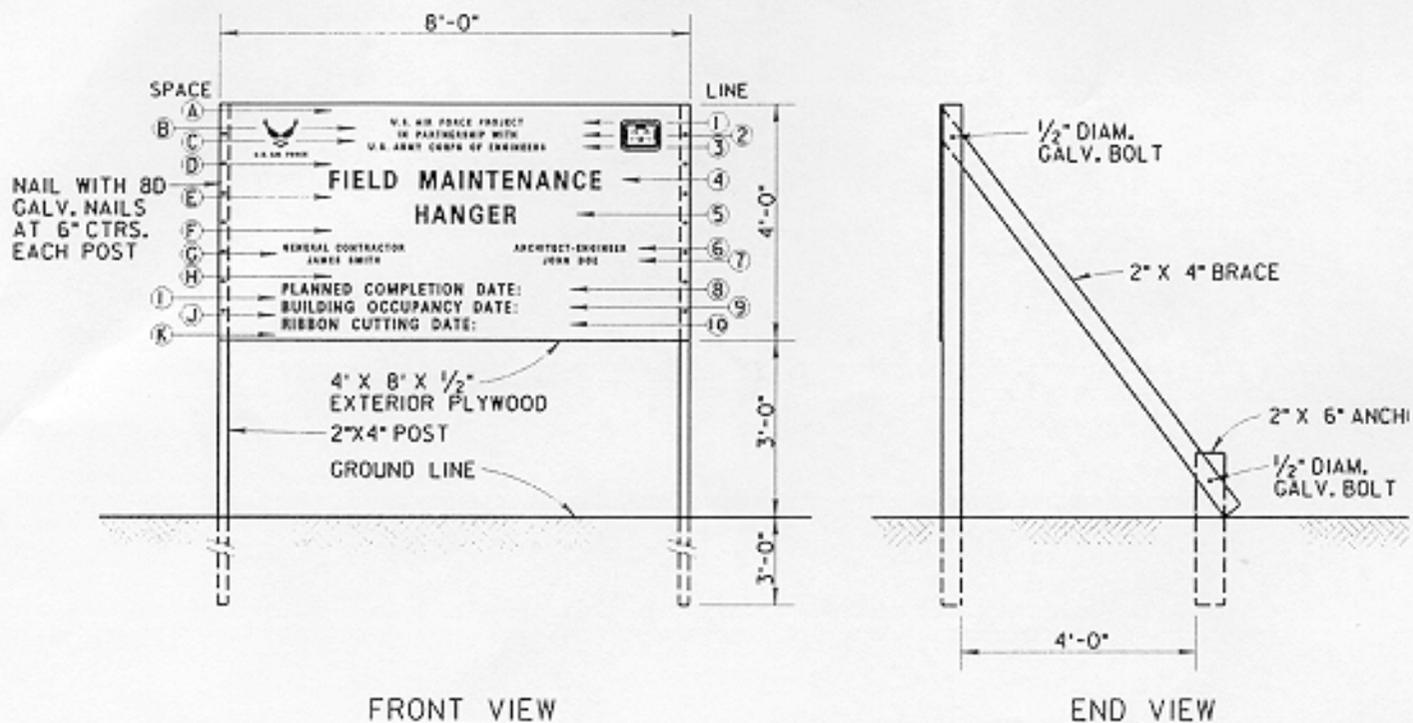
Legend Group 4: Standard safety record captions as shown. Typeface 1.25" Helvetica Regular; Color: Black.



Replaceable numbers are to be mounted on white 0.060 aluminum plates and screw-mounted to backdrop. Typeface: 3" Helvetica Regular; Color: Black; Plate size: 2.5"x 4.5".

# SIGN ERECTION DETAILS





**U.S. AIR FORCE ACC MCP PROJECTS  
PROJECT SIGN DETAILS**

NO SCALE

**SCHEDULE**

SPACE	HEIGHT	LINE	DESCRIPTION	LETTER HEIGHT	STROKE
A	3"	1	U.S. AIR FORCE PROJECT	1.5"	3/16"
B	1"	2	IN PARTNERSHIP WITH	1.5"	3/16"
C	1"	3	U.S. ARMY CORPS OF ENGINEERS	1.5"	3/16"
D	4"	4	PROJECT NAME	4"	1/2"
E	3"	5	PROJECT NAME CONT'D (IF REQ'D)	4"	1/2"
F	4"	6	GENERAL CONTRACTOR/A-E	1.5"	3/16"
G	1"	7	GENERAL CONTRACTOR/A-E	1.5"	3/16"
H	4"	8	PLANNED COMPLETION DATE	2.5"	1/4"
I	1"	9	BUILDING OCCUPANCY DATE	2.5"	1/4"
J	1"	10	RIBBON CUTTING DATE	2.5"	1/4"
K	2"				

**NOTES:**

1. POSTS SHALL BE S4S.
2. PLYWOOD SHALL BE EXTERIOR TYPE, A-C GRADE.
3. BEFORE PAINTING, SURFACE SHALL BE CLEAN, DRY, FREE OF GREASE AND SANDED.
4. PAINT WITH ONE EXTERIOR OIL PRIME COAT AND EXTERIOR TYPE ALKYD, CONFORMING TO MASTER PAINTERS INSTITUTE MPI-9, MPI GLOSS LEVEL 6. COLOR SHALL MATCH SHERWIN WILLIAMS SW 2175.
5. ALL LETTERING SHALL BE EXTERIOR TYPE ALKYD. COLOR SHALL MATCH SHERWIN WILLIAMS SW 1900.
6. DECALOMANIA FOR CORPS OF ENGINEERS INSIGNIA AND U.S. AIR FORCE EMBLEM WILL BE FURNISHED BY THE CONTRACTING OFFICER FOR INSTALLATION BY THE CONTRACTOR.
7. ALL EXPOSED WOOD (POSTS, SUPPORTS, BACK, ETC.) SHALL BE PAINTED THE SAME BACKGROUND COLOR AS THE SIGN.
8. LETTERING STYLE SHALL BE EITHER HELIOS EXTRA BOLD CONDENSED, HELIOS BOLD II, HELVETICA BLACK ROMAN, OR HELVETICA BOLD ROMAN.

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SAMPLE LOCATION MAPS

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DOCUMENTATION

## **Section 4**

VIRGINIA ASBESTOS LICENSES

# REPORT

## Project Description

It is our understanding that Buildings 18, 20, and 21 will be demolished as part of the proposed scope of work. The bunker located adjacent to the parking lot of Building 18 will also be demolished as part of the scope of work. As part of the demolition, existing asbestos containing materials (ACM) and paint containing lead may be disturbed. These materials must be identified and appropriate precautions taken prior to their disturbance in order to protect workers and the environment.

attached table lists the sample materials, sample location, and laboratory results. Drawings showing the approximate sample locations are also attached.

As the sample results indicate, the following materials were determined to contain asbestos:

### Building 18

- Floor Tiles Under Carpet
- Built Up Roof
- Roof Flashing

### Building 20

- \*Ceiling Board
- Floor Tiles Under Carpet
- Step Tread
- Window Caulk

### Building 21

- Black Coating/Mastic on Concrete Wall
- Multiple Layers of Floor Tiles & Mastic
- Door Caulk
- Transite Wall
- \*Debris in Attic
- \*Furnace/Boiler Insulation
- \*Fibrous Duct in Crawl Space
- \*Debris in Crawl space
- Roof Flashing
- Tar in Pitch Pocket
- Caulk at Chimney
- Window Caulk

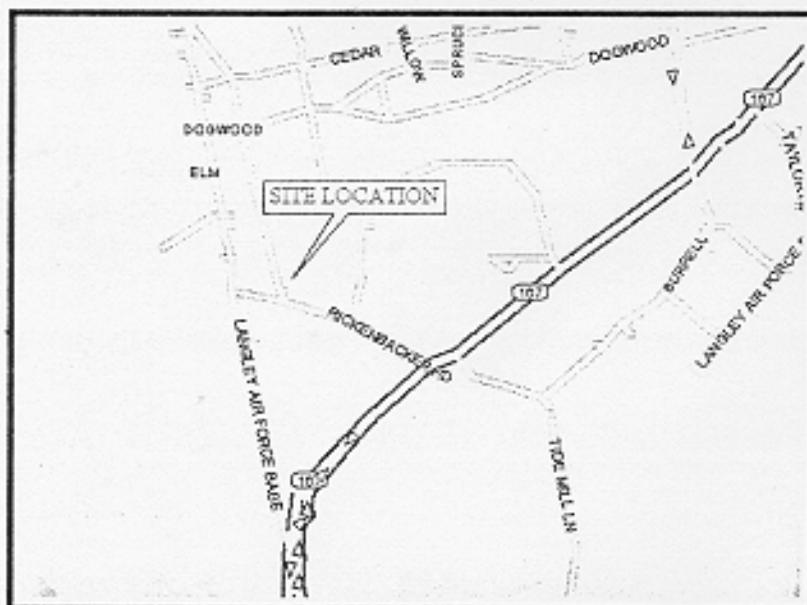


FIGURE 1: SITE LOCATION

\*Materials are friable and must be removed prior to demolition.

Our scope of work was to collect bulk samples of suspect asbestos-containing materials (ACM) and paint chip samples to determine lead concentrations. Destructive activities such as breaking into walls to obtain samples were not performed. Samples were collected from readily accessible areas.

## Asbestos Bulk Sampling Results

In July of 2002, one hundred forty-five bulk samples were collected of suspect asbestos-containing materials (ACM) by GER. The

We did not observe any suspect asbestos containing materials in the bunker. Therefore no samples were collected.

Samples were analyzed using polarized light microscopy (PLM) and dispersion staining techniques. The analytical method was conducted in accordance with the EPA-600/M4-82-020. Analysis was performed by Analytics Corporation, a NVLAP participant, NVLAP number 1004. To reduce laboratory costs, sample analysis was performed to the first positive asbestos sample per homogeneous material.

## Asbestos Discussion

The EPA defines asbestos-containing materials (ACM) as any material which contains greater than or equal to 1% asbestos by weight. The National Emissions Standard for Hazardous Air Pollutants (NESHAP), requires that all friable asbestos containing materials be removed prior to demolition.

For demolition projects, NESHAP, classifies roofing materials, floor tiles and mastic, step tread, transite, and caulking materials as Category I and II non-friable asbestos containing materials (ACM). Removal of Category I and II non-friable ACM is not required, prior to demolition, if materials are in good condition. However, wet methods must be used during the demolition process and personal and area air monitoring must be performed. Additionally, all demolition debris must be considered asbestos containing and be taken to a landfill that accepts Category I and II non-friable ACM.

Samples were analyzed using polarized light microscopy (PLM) and dispersion staining techniques. The analytical method was conducted in accordance with the EPA-600/M4-82-020. Analysis was performed by Analytics Corporation, a NVLAP participant, NVLAP number 1004. Destructive activities such as breaking into walls to obtain samples were not performed. Samples were collected from readily accessible areas.

## Lead Paint Sampling

Seventeen paint chip samples were collected by GER. The attached table lists the samples collected and laboratory results. Drawings showing the approximate sample locations are also attached.

The purpose of our sampling was to obtain representative data on the concentrations of lead in the existing painted surfaces scheduled for the demolition work. Our inspection services were not intended to meet the requirements of HUD sampling protocols for lead paint.

Paint samples were analyzed using inductively coupled plasma emission spectroscopy (ICP). The analytical method was conducted in accordance with the NIOSH 7082 Method by Analytics

Corporation, a National Lead Laboratory Accreditation Program (NLLAP) approved participant.

## Lead Paint Discussion

There are two frequently used standards to define lead-based paint, the Consumer Product and Safety Commission (CPSC) and the Department of Housing and Urban Development (HUD). In 1978, CPSC, acting under the authority of the Consumer Product Safety Act, banned the sale of paint containing more than 0.06% lead by weight to consumers. The Department of Housing and Urban Development (HUD) defines lead-based paint as any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm<sup>2</sup> as measured by x-ray fluorescence (XRF) analyzer or laboratory analysis, or 0.5% by weight as measured by laboratory analysis.

The Occupational Safety and Health Administration (OSHA) *Lead in Construction Standard (29 CFR 1926.62)* does not define lead-based paint. **However, to comply with OSHA, all painted surfaces with a lead concentration at or above the laboratory's minimum detection limit (MDL) should be considered lead containing.** Compliance with this standard is required even for paints with less than 0.5% or 0.06% lead by weight. Therefore, painted surfaces exceeding the MDL should not be disturbed without taking the appropriate precautions when performing certain high risk tasks. Activities such as scragging, sanding, welding/torching and disturbance of painted surfaces could potentially release leaded dust. OSHA has categorized the following high risks tasks into three groups:

- Group 1:
  - manual demolition
  - manual scragging
  - heat-gun applications
  - power tool cleaning with dust collection system
  - spray paint with lead-based paints
- Group 2:
  - lead burning
  - using lead-containing mortar
  - power tool cleaning without dust collection system
  - rivet blasting
  - cleanup activities where dry expendable abrasives are used

---

Group 3: movement and removal of abrasive blasting enclosures  
abrasive blasting  
welding, cutting and burning on steel structures

complying with 29 CFR 1926.62 in order to protect workers and the environment. We recommend that all paint located in the bunker is also considered lead containing based on its age.

As the results indicate, several samples collected contain lead concentrations above the laboratory's MDL. Therefore, we recommend that all existing painted surfaces scheduled for demolition be considered lead containing for the purposes of

Attachments-

- Section 2:** Bulk Sample Results/Laboratory Analysis Sheets/Sample Location Map
- Section 3:** Photographic Documentation
- Section 4:** Virginia Asbestos Licenses

Bulk Sample Results / Laboratory Analysis Sheets / Sample  
Location Maps

## Asbestos Bulk Sample Results

NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
1	Room 9	2'x 2' Recessed Drop Ceiling Tile	None Detected
2	Room 26	2'x 2' Recessed Drop Ceiling Tile	None Detected
3	Room 22	2'x 2' Drop Ceiling Tile	None Detected
4	Room 28	2'x 2' Drop Ceiling Tile	None Detected
5	Room 10	2'x 4' Drop Ceiling Tile	None Detected
6	Room 10	2'x 4' Drop Ceiling Tile	None Detected
7	Utility Closet	Plaster Ceiling	None Detected
8	Men's Room	Plaster Ceiling	None Detected
9	Room 10	Wall Covering	None Detected
10	Room 23	Wall Covering	None Detected
11	Room 26	Plaster Skim Coat on Concrete Block Wall	None Detected
12	Room 26	Plaster Skim Coat on Concrete Block Wall	None Detected
13	Room 23	Wallboard & Joint Compound	None Detected
14	Room 26	Wallboard & Joint Compound	None Detected
15	Room 10	Carpet Mastic	None Detected
16	Room 27	Carpet Mastic	None Detected
<b>17</b>	<b>Room 3</b>	<b>Floor Tile Under Carpet</b>	<b>10% Chrysotile</b>
<b>18</b>	<b>Room 27</b>	<b>Floor Tile Under Carpet</b>	<b>Not Analyzed, Assume +, See #17</b>
19	Room 28	4" Black Covebase & Mastic	None Detected
20	Room 28	4" Black Covebase & Mastic	None Detected
21	Bathroom	12" Grey Floor Tile & Mastic	None Detected
22	Bathroom	12" Grey Floor Tile & Mastic	None Detected
23	Bathroom	4" Grey Covebase & Mastic	None Detected
24	Bathroom	4" Grey Covebase & Mastic	None Detected
25	Hall Above Drop Ceiling Tiles	Caulk on Pipe Insulation Wrap	None Detected
26	Hall Above Drop Ceiling Tiles	Caulk on Pipe Insulation Wrap	None Detected
27	Room 26, Above Drop Ceiling Tiles	Caulk on Metal Duct	None Detected
28	Room 26, Above Drop Ceiling Tiles	Caulk on Metal Duct	None Detected
29	Room 27, Above Drop Ceiling Tiles	Caulk on Duct Insulation Wrap	None Detected
30	Room 27, Above Drop Ceiling Tiles	Caulk on Duct Insulation Wrap	None Detected
31	Exterior	Caulk on Gutter	None Detected
32	Exterior	Caulk on Gutter	None Detected
33	Exterior	Stucco Wall	None Detected
34	Exterior	Stucco Wall	None Detected
35	Exterior	Stucco Wall	None Detected
36	Exterior	Door Caulk	None Detected
37	Exterior	Door Caulk	None Detected
38	Exterior	Window Caulk	None Detected
39	Exterior	Window Caulk	None Detected

Asbestos Bulk Sample Results

NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
40	Roof	Built Up Roof	None Detected
41	Roof	Built Up Roof	None Detected
42	Roof	Built Up Roof	None Detected
43	<i>Roof</i>	<i>Built Up Roof, 2nd roof</i>	<i>50% Chrysotile</i>
44	<i>Roof</i>	<i>Built Up Roof, 2nd roof</i>	<i>Not Analyzed, Assume +, See #43</i>
45	Roof	Built Up Roof, 2nd roof	None Detected
46	Roof	Roof Flashing	None Detected
47	<i>Roof</i>	<i>Roof Flashing</i>	<i>10% Chrysotile</i>
48	Roof	Mastic on Flashing	None Detected
49	Roof	Mastic on Flashing	None Detected

LEAD PAINT CHIP SAMPLE RESULTS

NO.	SAMPLE LOCATION	COLOR	% LEAD	> HUD 0.5%	> CPSC 0.06%	> MDL 0.005%
1	Exterior, stucco wall	Brown	<0.005			
2	Exterior, concrete column	Tan	<0.005			
3	Room 27, metal door frame	Brown	<0.005			
4	Room 26, concrete wall	Tan	0.016			<b>X</b>



**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
  - NEGATIVE SAMPLE LOCATION FOR ASBESTOS
  - PAINT CHIP SAMPLE LOCATION
- NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.

# SAMPLE LOCATION PLAN

Project: Demolition of Building 18  
Langley Air Force Base, VA

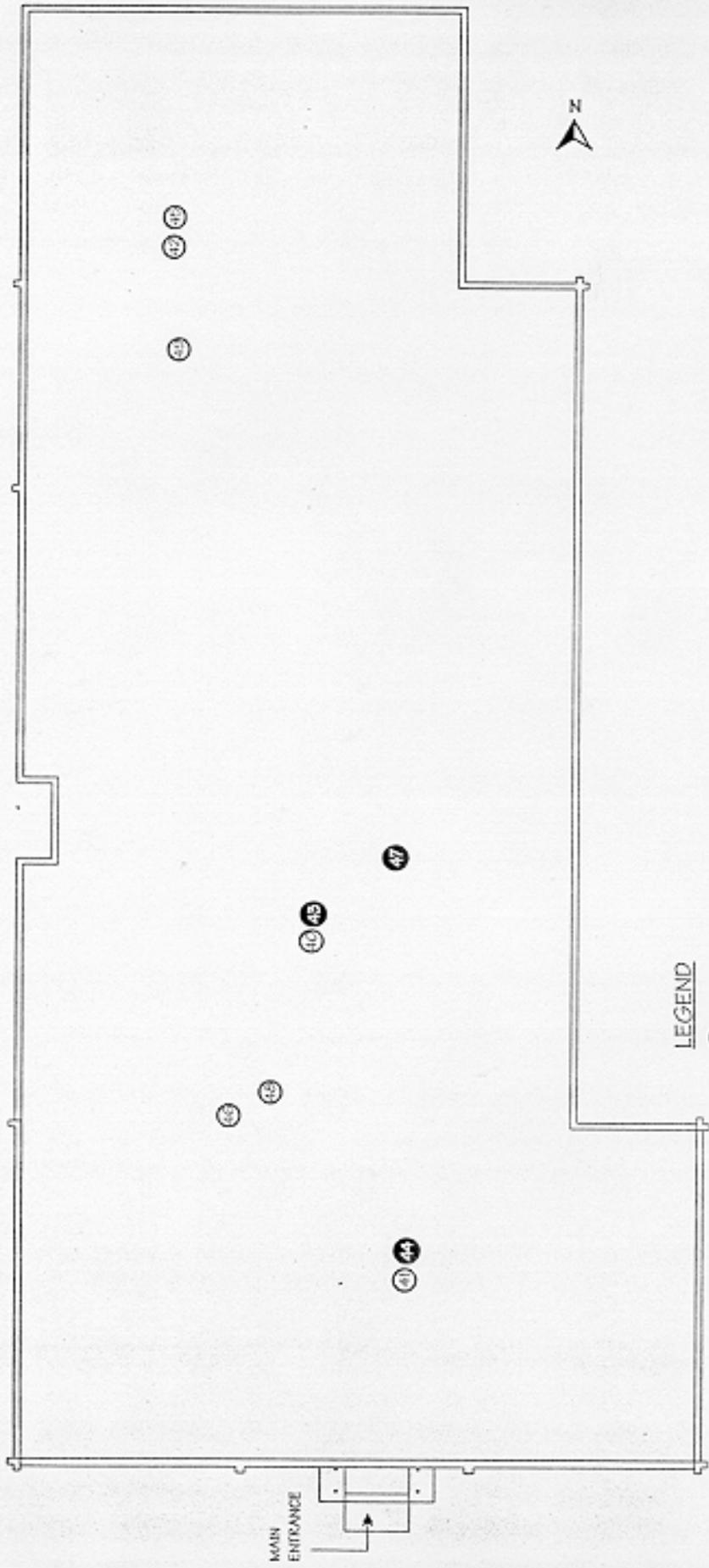
DATE: July 21, 2002

Number: 130-3020

SCALE: NONE

**GEO ENVIRONMENTAL RESOURCES, INC.**  
Consulting • Environmental • Remediation • Geotechnical • Geospatial • Industrial Engineering • Construction





**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION

NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.

# SAMPLE LOCATION PLAN

Project: Demolition of Building 18  
 Roof  
 Langley Air Force Base, VA  
 Number: 130-3020

Date: July 21, 2002

Scale: None

**GEO ENVIRONMENTAL RESOURCES, INC.**  
 Geotechnical • Environmental • Hazardous Materials • Construction • Industrial Engineering, Consulting

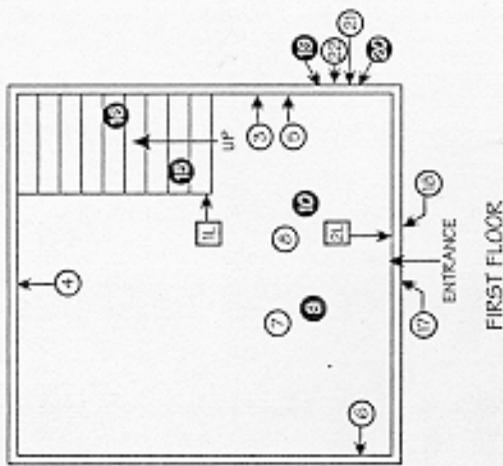


Asbestos Bulk Sample Results

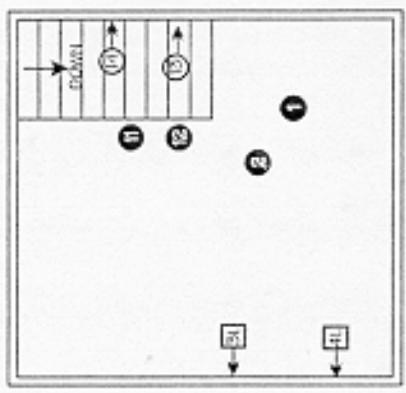
NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
1	2nd Floor	Ceiling Board	10% Chrysotile
2	2nd Floor	Ceiling Board	Not Analyzed, Assume +, See #1
3	1st Floor	Wallboard & Joint Compound	None Detected
4	1st Floor	Wallboard & Joint Compound	None Detected
5	1st Floor	Wall Covering	None Detected
6	1st Floor	Wall Covering	None Detected
7	1st Floor	Carpet Mastic	None Detected
8	1st Floor	Carpet Mastic	None Detected
9	1st Floor	Black Floor Tile & Mastic Under Carpet	20% Chrysotile
10	1st Floor	Black Floor Tile & Mastic Under Carpet	Not Analyzed, Assume +, See #9
11	2nd Floor	Tan Floor Tile & Mastic Under Carpet	20% Chrysotile
12	2nd Floor	Tan Floor Tile & Mastic Under Carpet	Not Analyzed, Assume +, See #11
13	2nd Floor	Pipe Insulation Wrap	None Detected
14	2nd Floor	Pipe Insulation Wrap	None Detected
15	1st Floor	Step Tread	20% Chrysotile
16	1st Floor	Step Tread	Not Analyzed, Assume +, See #15
17	Exterior	Door Caulk	None Detected
18	Exterior	Door Caulk	None Detected
19	Exterior	Window Caulk	15% Chrysotile
20	Exterior	Window Caulk	Not Analyzed, Assume +, See #19
21	Exterior	Window Glazing Compound	None Detected
22	Exterior	Window Glazing Compound	None Detected
23	Roof	Built Up Roof	None Detected
24	Roof	Built Up Roof	None Detected

LEAD PAINT CHIP SAMPLE RESULTS

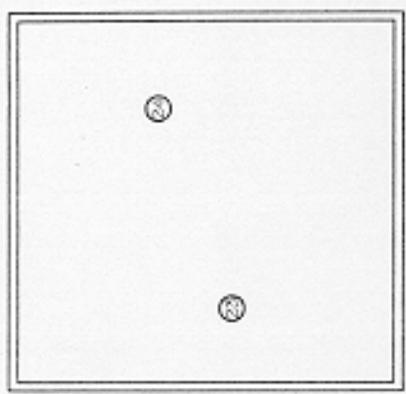
NO.	SAMPLE LOCATION	COLOR	% LEAD	> HUD 0.5%	> CPSC 0.06%	> MDL 0.005%
1	1st Floor, wood stair hand rail	Grey	0.072		X	X
2	1st Floor, wood door frame	White	<0.005			
3	2nd Floor, wood molding	Tan	0.123		X	X
4	2nd Floor, brick wall	Tan	0.03			X



FIRST FLOOR



SECOND FLOOR



ROOF



LEGEND

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION

NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.

# SAMPLE LOCATION PLAN

PROJECT: Demolition of Building 20  
Langley Air Force Base, VA

Number: 130-3020

DATE: July 21, 2002

SCALE: NONE

**GEO ENVIRONMENTAL RESOURCES, INC.**  
Geotechnical • Environmental • Hazardous Materials • Construction • Industrial Engineering, Consulting



## Asbestos Bulk Sample Results

NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
1	Room Outside 113	Ceiling Insulation	None Detected
2	Room Outside 113	Ceiling Insulation	None Detected
3	Room Outside 113	Wallboard behind Ceiling Insulation	None Detected
4	Room Outside 113	Wallboard behind Ceiling Insulation	None Detected
5	Foyer Above Drop Ceiling Tiles	Wallboard & Joint Compound	None Detected
6	2nd Floor, Projection Room	Wallboard & Joint Compound	None Detected
7	Room 118	Plaster Skim Coat w/ Wallboard	None Detected
8	2nd Floor, Open Office	Plaster Skim Coat w/ Wallboard	None Detected
9	1st Floor, Vault	2'x 2' Drop Ceiling Tile	None Detected
10	Foyer	2'x 2' Drop Ceiling Tile	None Detected
11	2nd Floor, Open Office	2'x 2' Drop Ceiling Tile	None Detected
12	2nd Floor Open, Office	2'x 2' Drop Ceiling Tile	None Detected
13	Room 108	2'x 4' Drop Ceiling Tile	None Detected
14	Room 108	2'x 4' Drop Ceiling Tile	None Detected
15	2nd Floor, Hall, above drop ceiling tiles	Concrete Wall w/ Black Coating	>1-5% Chrysotile in Black Coating
16	2nd Floor, Hall, above drop ceiling tiles	Concrete Wall w/ Black Coating	Not Analyzed, Assume +, See #15
17	1st Floor, Soda Machine Room	Concrete Wall	None Detected
18	1st Floor, Soda Machine Room	Concrete Wall	None Detected
19	Room 116	Wall Covering	None Detected
20	2nd Floor, Hall	Wall Covering	None Detected
21	1st Floor, Men's Room	4" Brown Covebase & Mastic	None Detected
22	1st Floor, Women's Room	4" Brown Covebase & Mastic	None Detected
23	1st Floor, Soda Machine Room	4" Grey Covebase & Mastic	None Detected
24	1st Floor, Soda Machine Room	4" Grey Covebase & Mastic	None Detected
25	Room Outside 113	9" Green Floor Tile & Mastic	10% Chrysotile in Tile Only
26	2nd Floor, Hall, Under Carpet	9" Green Floor Tile & Mastic	Not Analyzed, Assume +, See #25
27	Room Outside 113, 2nd & 3rd Layer	Black & Brown Floor Tile & Mastic	10% Chrysotile
28	2nd Floor, Projection Room	Black & Brown Floor Tile & Mastic	Not Analyzed, Assume +, See #27
29	1st Floor, Women's Room	Floor Covering	None Detected
30	2nd Floor, Men's Room	Floor Covering	None Detected

## Asbestos Bulk Sample Results

NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
31	1st Floor, Hall	Carpet Mastic	None Detected
32	2nd Floor, Hall @ Projection Room	Carpet Mastic	None Detected
33	Foyer, Above Drop Ceiling Tiles	Pipe Insulation Wrap	None Detected
34	Foyer, Above Drop Ceiling Tiles	Pipe Insulation Wrap	None Detected
35	Room 116 (no mastic, nailed in)	1'x 1' Acoustical Ceiling Tile	None Detected
36	2nd Floor, Projection Room	1'x 1' Acoustical Ceiling Tile	None Detected
37	<i>Exterior, Boiler Room</i>	<i>Door Caulk</i>	<i>10% Chrysotile</i>
38	<i>Exterior, Boiler Room</i>	<i>Door Caulk</i>	<i>Not Analyzed, Assume +, See #37</i>
39	Room 212	Window Caulk	None Detected
40	Room 212	Window Caulk	None Detected
41	Room 118	1'x 1' Acoustical Ceiling Tile	None Detected
42	Room 118	1'x 1' Acoustical Ceiling Tile	None Detected
43	<i>2nd Floor, Fire Extinguisher Cabinet, back wall</i>	<i>Transite Panel</i>	<i>30% Chrysotile</i>
44	<i>Attic, Room 206, above acoustical ceiling tiles</i>	<i>Debris</i>	<i>70% Chrysotile</i>
45	Crawl Space	Clear Mastic on Dust Insulation Wrap	None Detected
46	Crawl Space	Clear Mastic on Dust Insulation Wrap	None Detected
47	Boiler Room	Light Weight Concrete Wall	None Detected
48	Boiler Room	Light Weight Concrete Wall	None Detected
49	Boiler Room	Grey Caulk on Duct Insulation Wrap	None Detected
50	Boiler Room	Grey Caulk on Duct Insulation Wrap	None Detected
51	Boiler Room	Wallboard Column	None Detected
52	Boiler Room	Wallboard Column	None Detected
53	<i>Boiler Room</i>	<i>Furnace/Boiler Insulation, marked "asbestos containing material"</i>	<i>80% Chrysotile</i>
54	Boiler Room	Expansion Tank Insulation	None Detected
55	<i>Crawl Space</i>	<i>Debris</i>	<i>70% Chrysotile</i>
56	<i>Crawl Space</i>	<i>Duct Material</i>	<i>70% Chrysotile</i>
57	Addition Roof	Built Up Roof	None Detected
58	Lower Roof	Built Up Roof	None Detected
59	Upper Roof	Built Up Roof	None Detected
60	Upper Roof	Built Up Roof	None Detected
61	<i>Addition Roof</i>	<i>Flashing</i>	<i>20% Chrysotile</i>
62	<i>Lower Roof</i>	<i>Flashing</i>	<i>Not Analyzed, Assume +, See #61</i>

Asbestos Bulk Sample Results

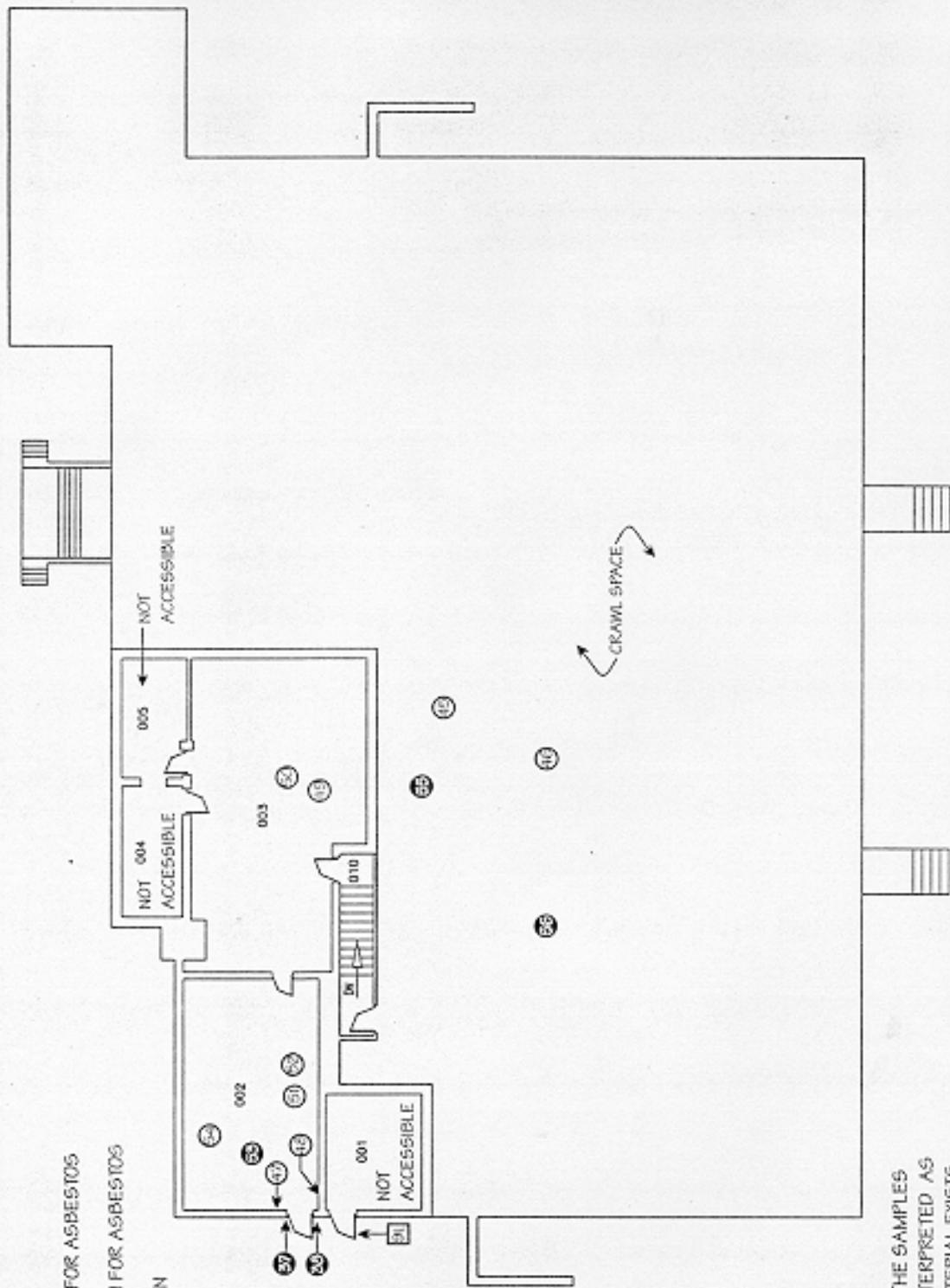
NO.	SAMPLE LOCATION	SAMPLE MATERIAL	% & TYPE ASBESTOS
63	<i>Upper Roof @ Chimney</i>	<i>Flashing</i>	<i>20% Chrysotile</i>
64	<i>Upper Roof @ Chimney</i>	<i>Flashing</i>	<i>Not Analyzed, Assume +, See #63</i>
65	<i>Upper Roof</i>	<i>Tar in Pitch Pocket</i>	<i>20% Chrysotile</i>
66	<i>Upper Roof</i>	<i>Tar in Pitch Pocket</i>	<i>Not Analyzed, Assume +, See #65</i>
67	Addition Roof	Caulk on Counter Flashing	None Detected
68	Lower Roof	Caulk on Counter Flashing	None Detected
69	Upper Roof	Caulk on Chimney	None Detected
70	<i>Upper Roof</i>	<i>Caulk on Chimney</i>	<i>10% Chrysotile</i>
71	At Lower Roof	Window Caulk	None Detected
72	<i>At Lower Roof</i>	<i>Window Caulk</i>	<i>5% Chrysotile</i>

LEAD PAINT CHIP SAMPLE RESULTS

NO.	SAMPLE LOCATION	COLOR	% LEAD	> HUD 0.5%	> CPSC 0.06%	> MDL 0.005%
1	Exterior, metal awning ceiling	Brown	0.014			X
2	1st Floor, Soda Machine Rm, metal conduit	Tan	0.079		X	X
3	1st Floor, Utility Closet, wood shelf	Tan	0.007			X
4	1st Floor, Men's Rm, wallboard ceiling	Tan	<0.005			
5	1st Floor, Men's Rm, wood door	Brown	0.167		X	X
6	Office 116, wood door frame	White	0.154		X	X
7	Office 212, wood window sill	White	0.23		X	X
8	2nd Floor, Project Rm, wood door frame	White	12.8	X	X	X
9	Exterior, Boiler Rm, wood door	Brown	<0.005			

**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION



NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.

# SAMPLE LOCATION PLAN

PROJECT: Demolition of Building 21  
BASEMENT  
LANGLEY AIR FORCE BASE, VA

DATE: July 21, 2002

SCALE: NONE

Number: 130-3020

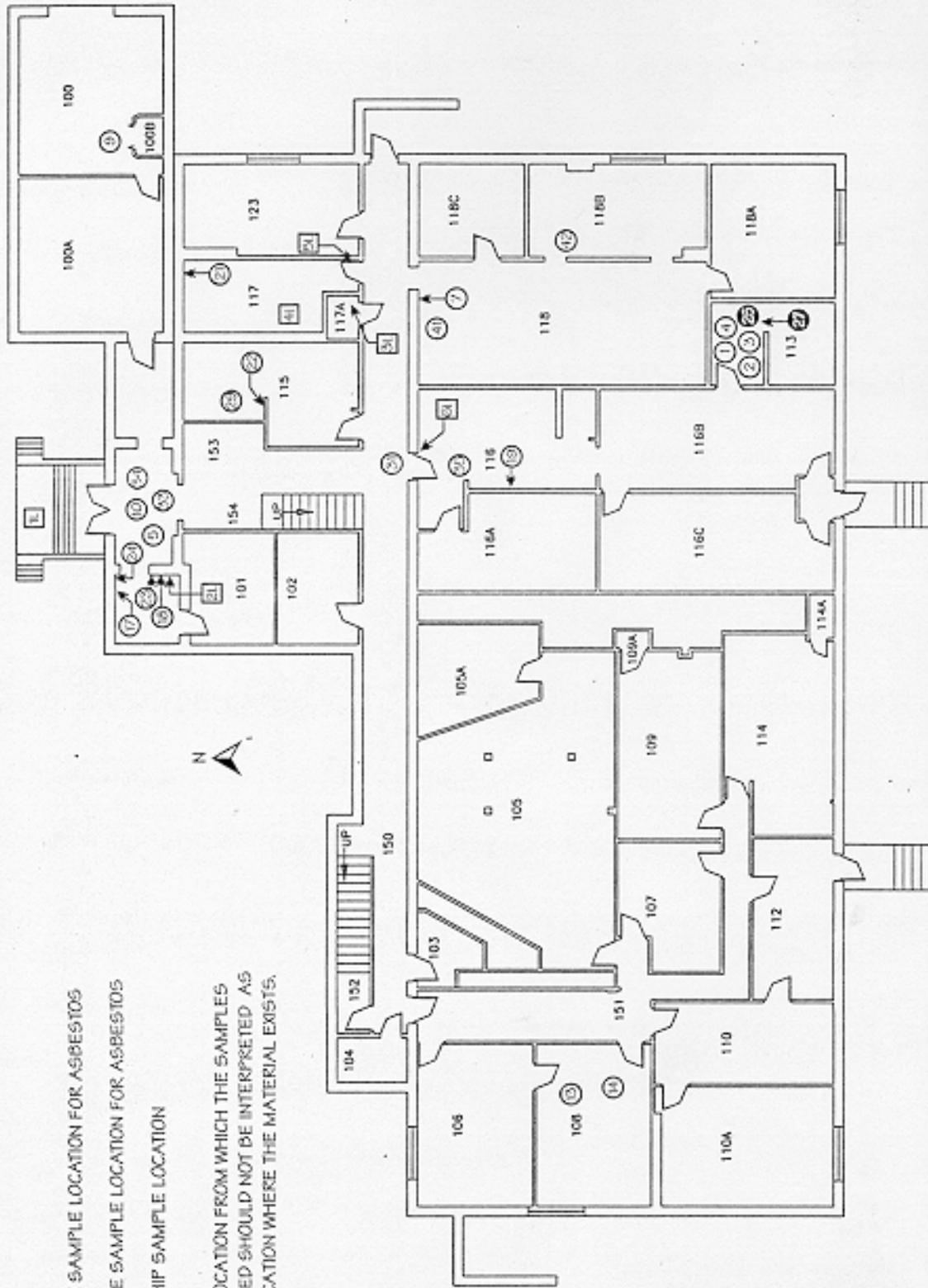
**GEO ENVIRONMENTAL RESOURCES, INC.**  
Consulting • Environmental • Hazardous Materials • Geotechnical • Industrial Engineering, Construction



**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION

NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.



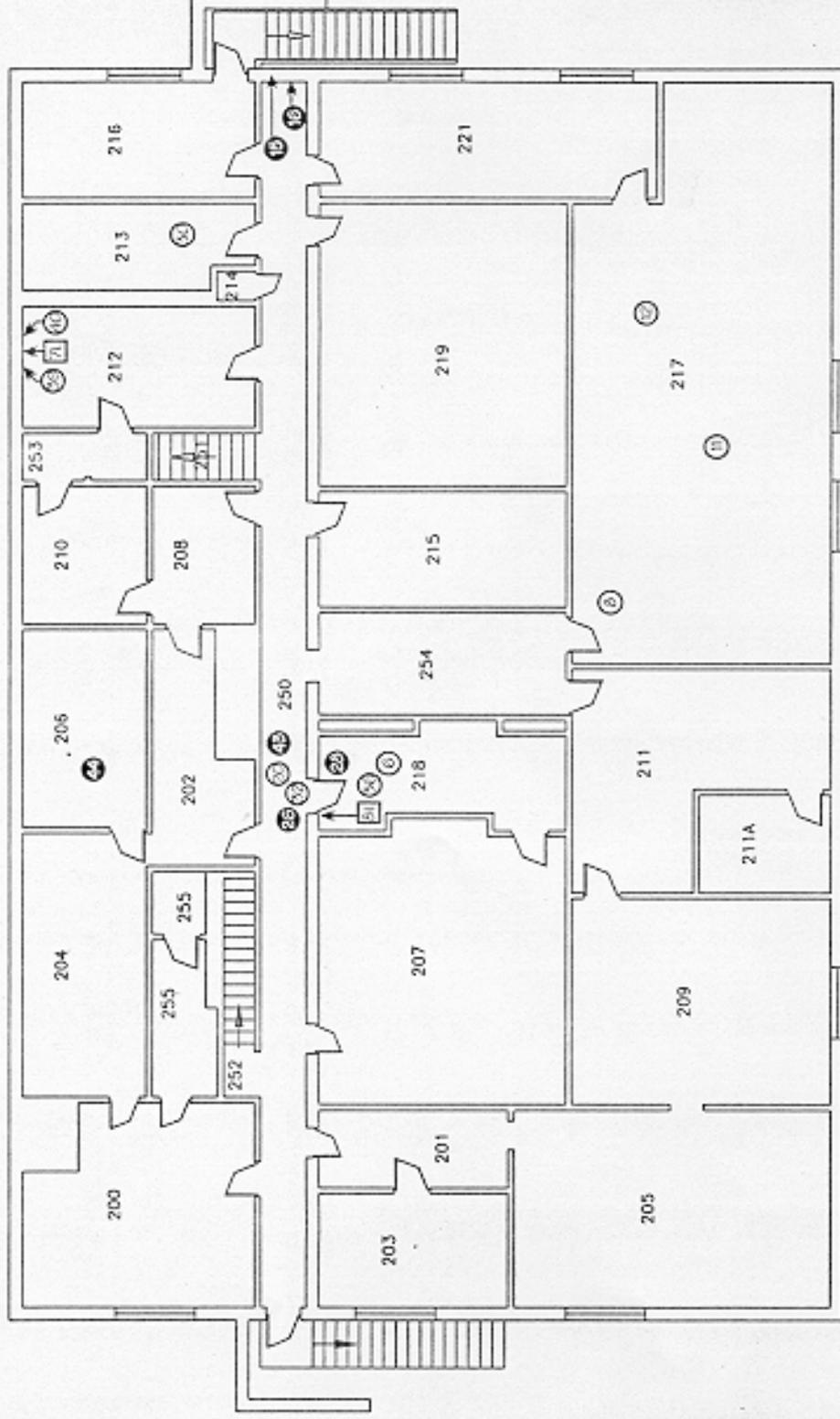
# SAMPLE LOCATION PLAN

Project: Demolition of Building 21  
1st Floor  
Langley Air Force Base, VA  
Number: 130-3020

DATE: July 21, 2002  
SCALE: NONE

**GEO ENVIRONMENTAL RESOURCES, INC.**  
Geotechnical • Environmental • Hazardous Materials • Construction • Industrial Engineering, Consultants





**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION

NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.

# SAMPLE LOCATION PLAN

Project: Demolition of Building 21  
 2nd Floor  
 Langley Air Force Base, VA  
 Number: 130-3020

DATE: July 21, 2002  
 SCALE: NONE

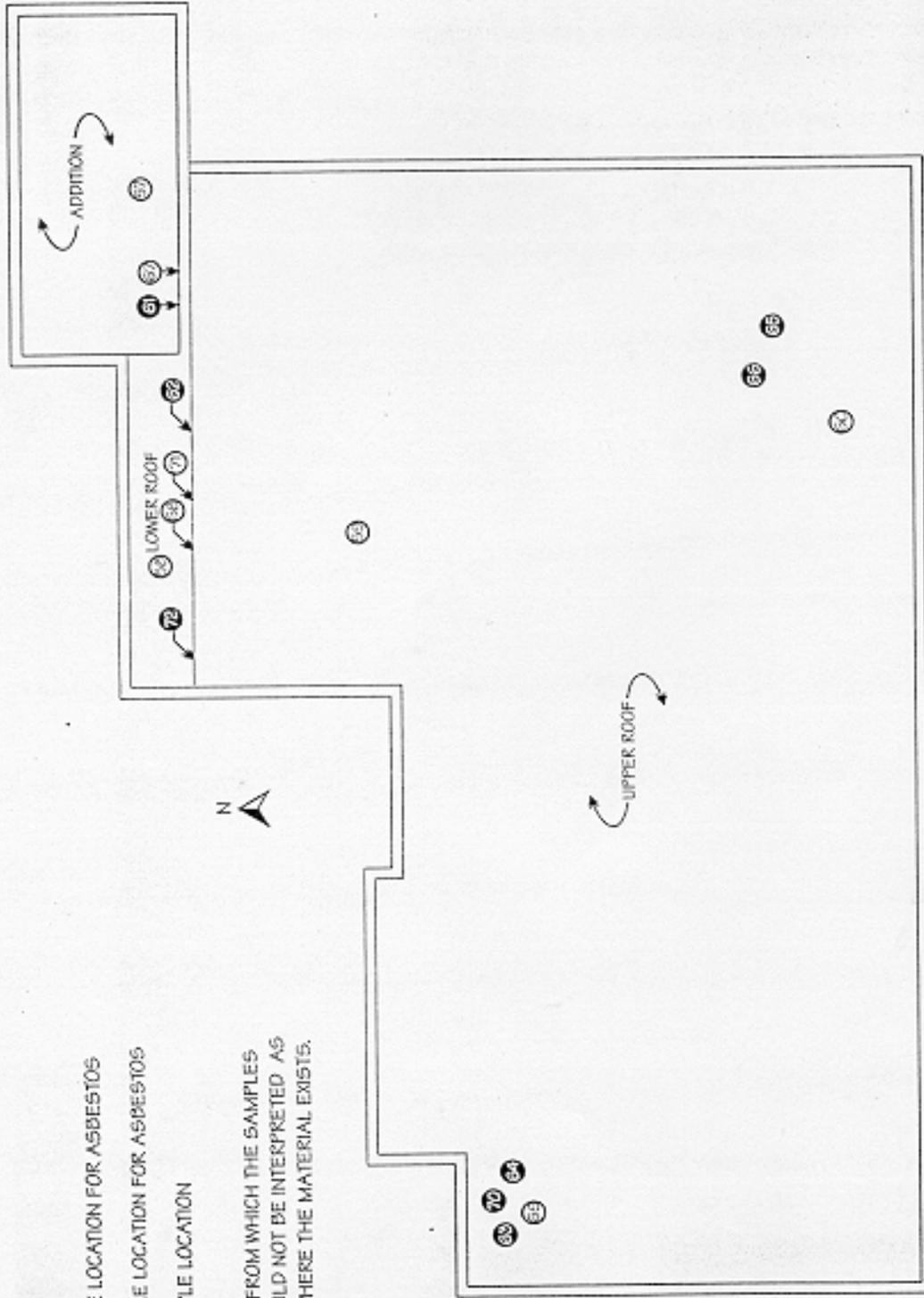
**GEO ENVIRONMENTAL RESOURCES, INC.**  
 Geotechnical • Environmental • Hazardous Materials • Construction • Industrial Engineering, Consulting



**LEGEND**

- POSITIVE SAMPLE LOCATION FOR ASBESTOS
- NEGATIVE SAMPLE LOCATION FOR ASBESTOS
- PAINT CHIP SAMPLE LOCATION

NOTE - THE LOCATION FROM WHICH THE SAMPLES WERE OBTAINED SHOULD NOT BE INTERPRETED AS THE ONLY LOCATION WHERE THE MATERIAL EXISTS.



# SAMPLE LOCATION PLAN

Project: Demolition of Building 21  
Roof  
Langley Air Force Base, VA

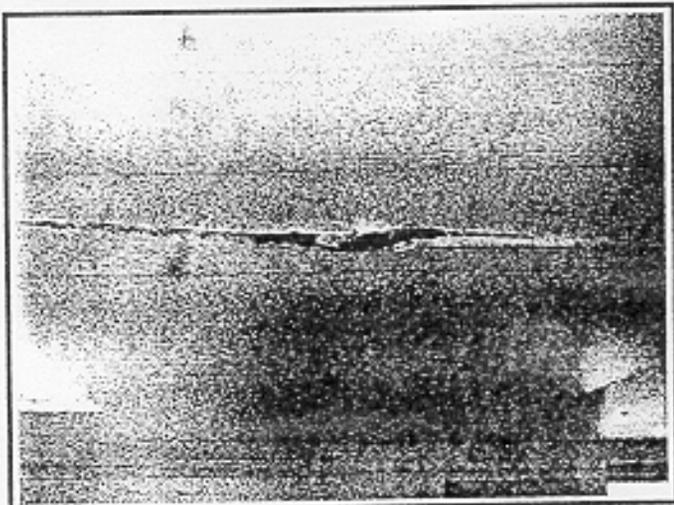
DATE: July 21, 2002  
SCALE: NONE

Number: 130-3020

**GEO ENVIRONMENTAL RESOURCES, INC.**  
Geotechnical • Environmental • Hazardous Materials • Cleanups • Remediation • Construction • Civil

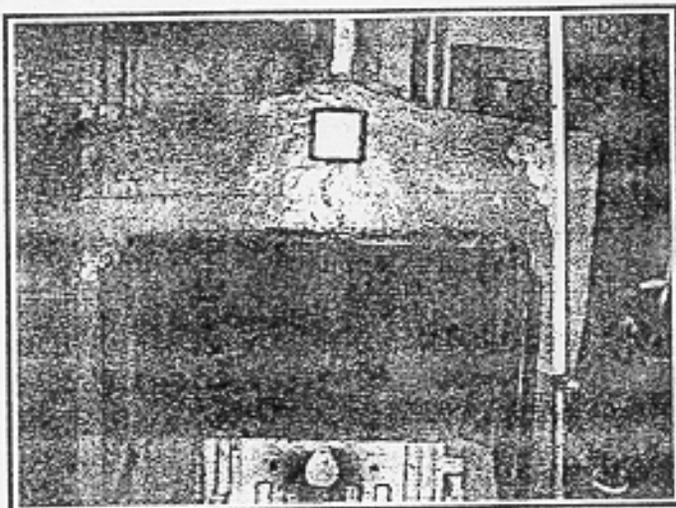


PHOTOGRAPHIC DOCUMENTATION

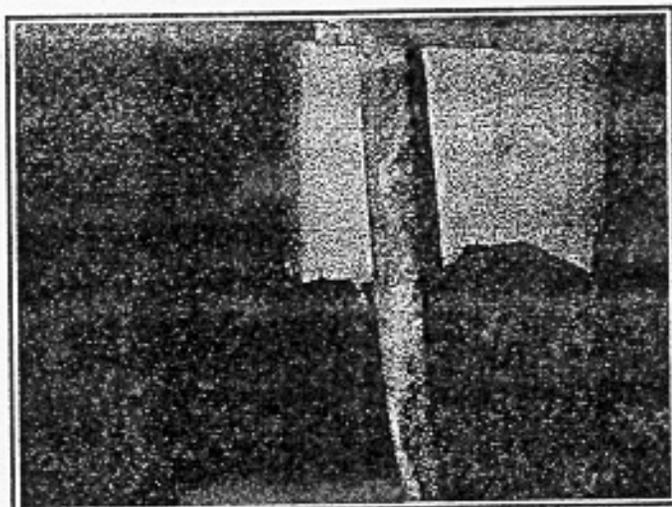


← PHOTO 1: BUILDING 20, 2ND FLOOR, ASBESTOS CEILING BOARD

PHOTO 2: BUILDING 21, BOILER ROOM, ASBESTOS CONTAINING FURNACE INSULATION (LABELED) →



← PHOTO 3: BUILDING 21, CRAWLSPACE, WHITE ASBESTOS DUCT PENETRATING THROUGH FLOOR BOARD



## SITE PHOTOGRAPHS

PROJECT: DEMOLITION of Buildings 18, 20 & 21  
LANGLEY AIR FORCE BASE  
HAMPTON, VIRGINIA

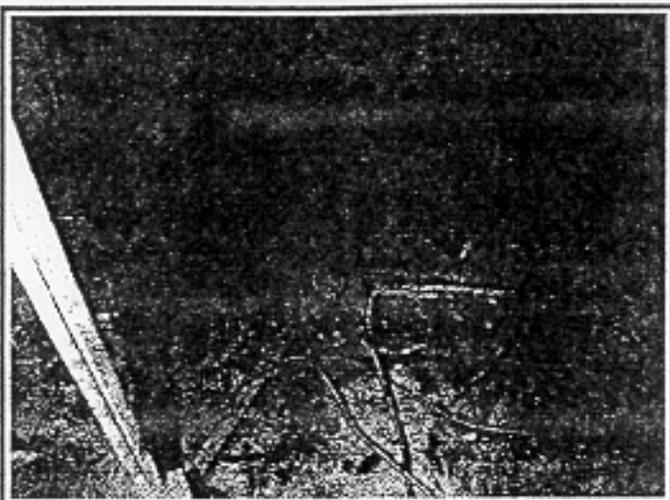
NUMBER: 130-3020

DATE: August 6, 2002

**GEOENVIRONMENTAL RESOURCES, INC.**  
CORPORATE • ENVIRONMENTAL • HAZARDOUS MATERIALS • GEOTECHNICAL • INDUSTRIAL ENGINEERING CONSULTANTS

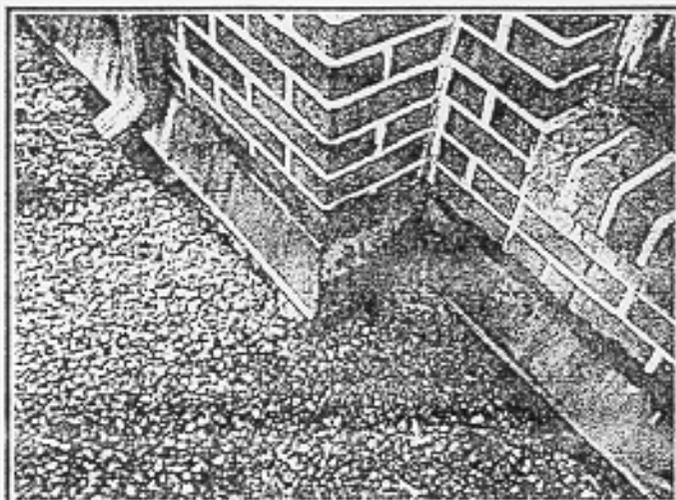


PHOTO SHEET 1 of 2

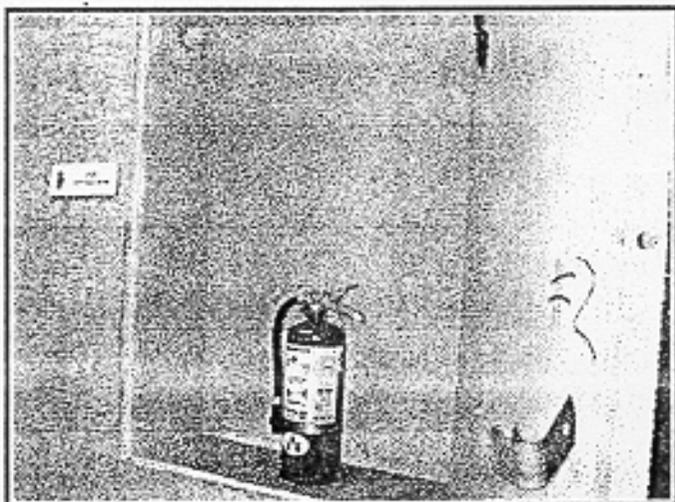


← PHOTO 4: BUILDING 21, CRAWL SPACE, ASBESTOS DEBRIS

PHOTO 5: BUILDING 21, ROOF, ASBESTOS CONTAINING MASTIC AND FLASHING



← PHOTO 6: BUILDING 21, 2ND FLOOR, ASBESTOS PANEL BEHIND FIRE EXTINGUISHER



## SITE PHOTOGRAPHS

PROJECT: Demolition of Buildings 18, 20 & 21  
Langley Air Force Base  
Hampton, Virginia

NUMBER: 130-3020

DATE: August 6, 2002

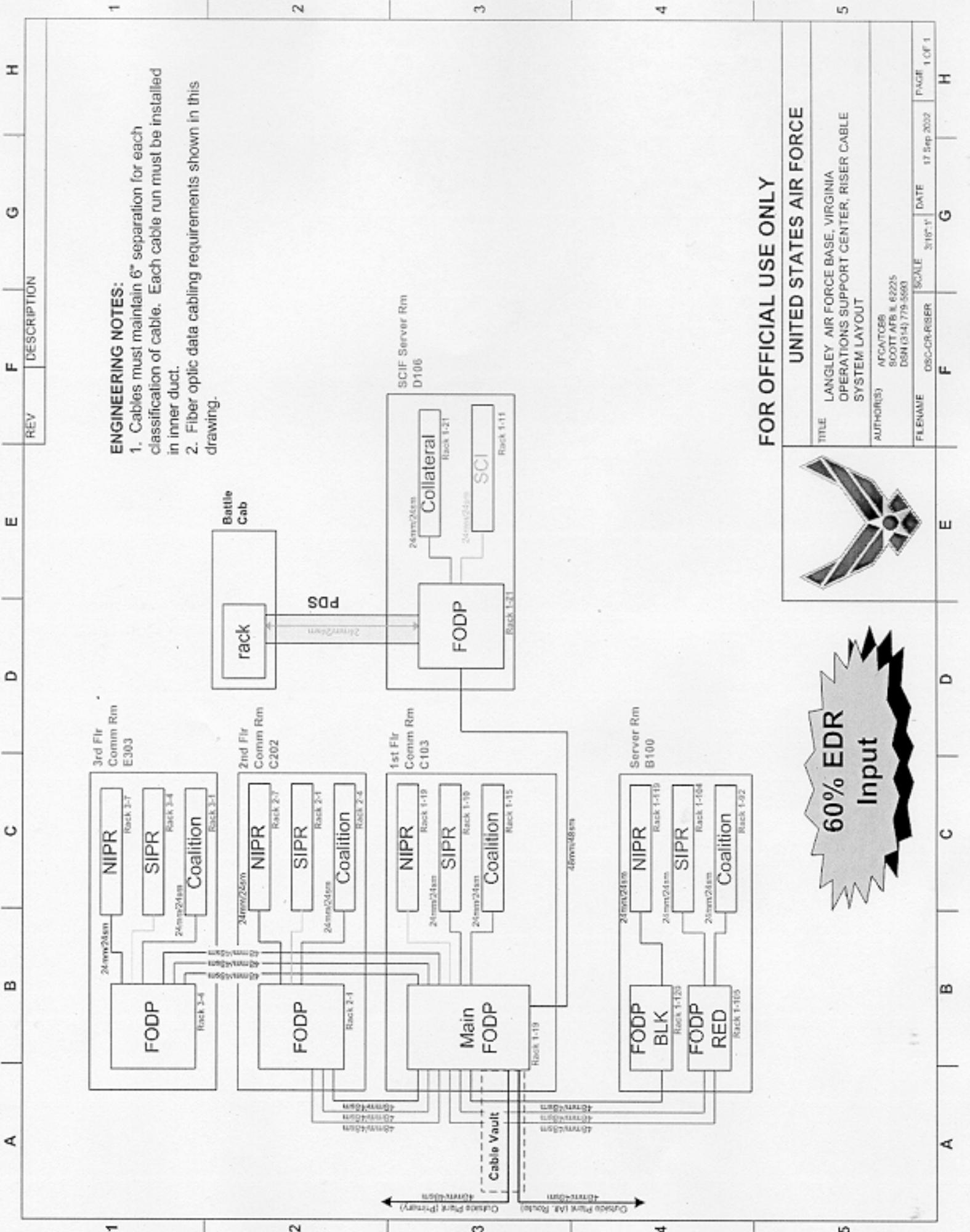
**GEOENVIRONMENTAL RESOURCES, INC.**  
Geotechnical • Environmental • Hazardous Materials • Construction • Industrial Engineering, Consulting



PHOTO SHEET 2 of 2

VIRGINIA ASBESTOS LICENSES

**APPENDIX A**  
**SPECIFICATION SECTION 16710**  
**PREMISES DISTRIBUTION SYSTEM**



**ENGINEERING NOTES:**

1. Cables must maintain 6" separation for each classification of cable. Each cable run must be installed in inner duct.
2. Fiber optic data cabling requirements shown in this drawing.

**FOR OFFICIAL USE ONLY**



**60% EDR  
Input**

**UNITED STATES AIR FORCE**

TITLE  
LANGLEY AIR FORCE BASE, VIRGINIA  
OPERATIONS SUPPORT CENTER, RISER CABLE  
SYSTEM LAYOUT

AUTHOR(S)  
AFCANTC66  
SCOTT AFB IL 62225  
DSN (314) 779-5690

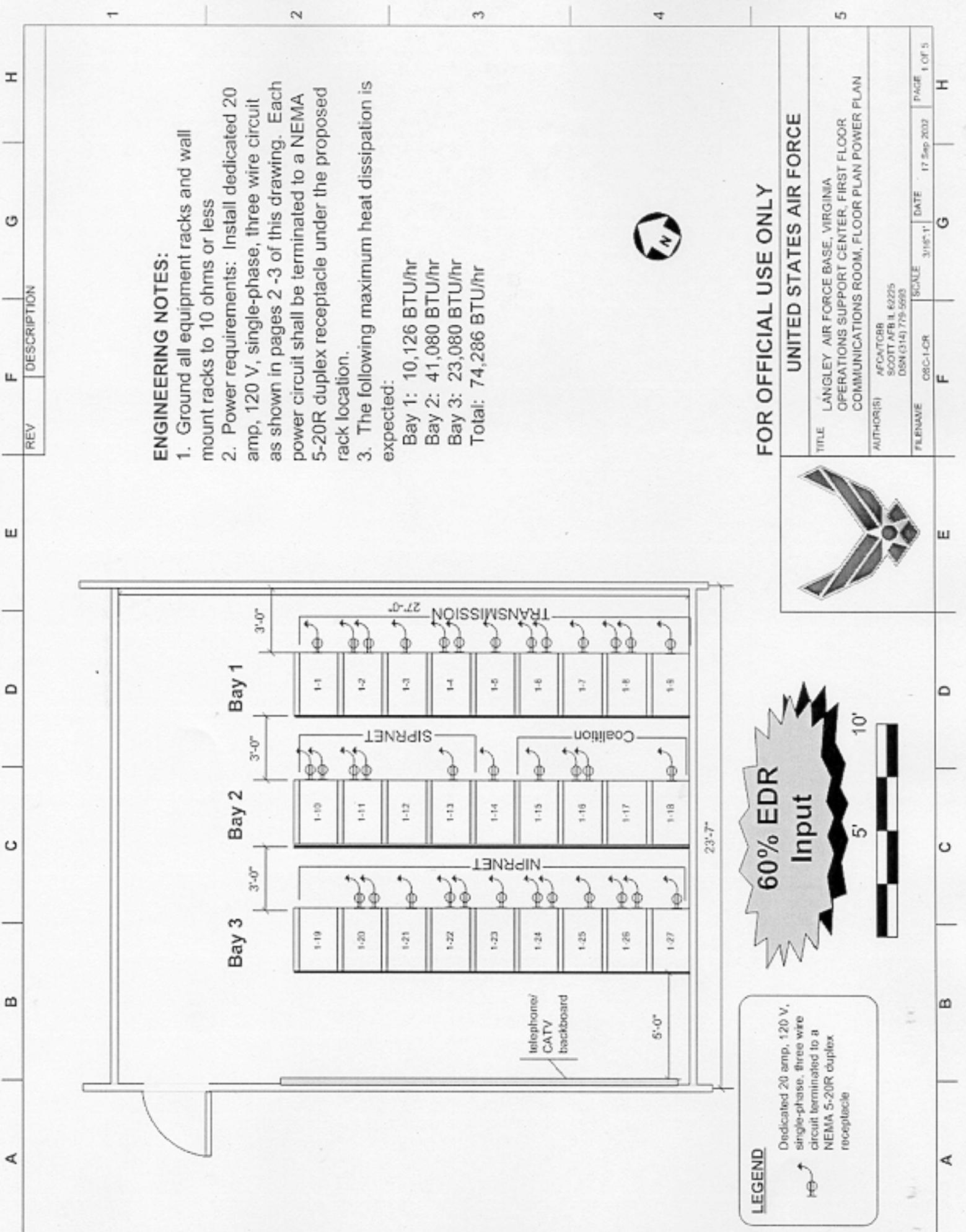
FILENAME  
OSC-CR-RISER

SCALE  
3/16"=1'

DATE  
17 Sep 2002

PAGE  
1 OF 1





**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown in pages 2 -3 of this drawing. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:

Bay 1: 10,126 BTU/hr  
 Bay 2: 41,080 BTU/hr  
 Bay 3: 23,080 BTU/hr  
 Total: 74,286 BTU/hr



**LEGEND**


 Dedicated 20 amp, 120 V, single-phase, three wire circuit terminated to a NEMA 5-20R duplex receptacle

**60% EDR Input**

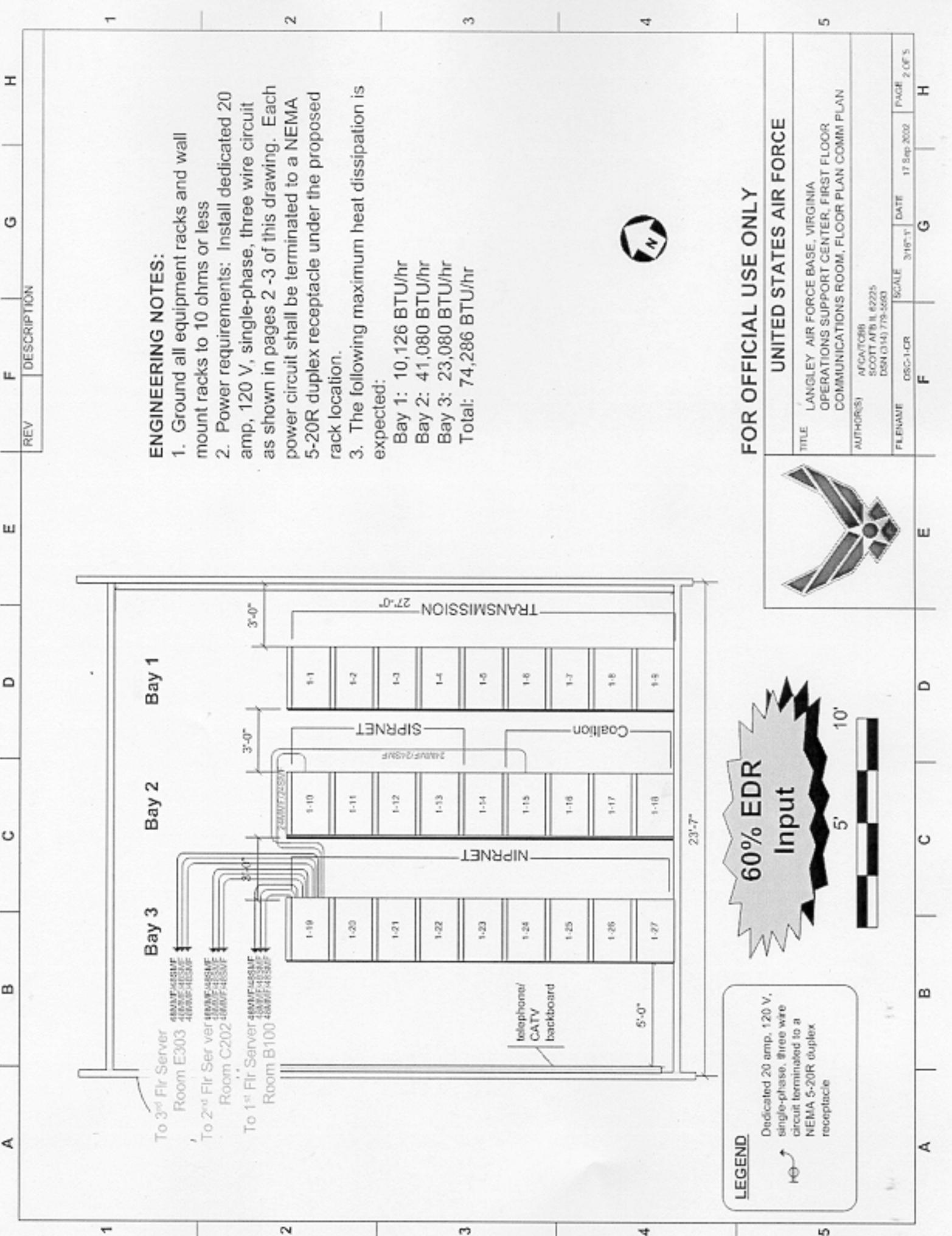


**FOR OFFICIAL USE ONLY**

**UNITED STATES AIR FORCE**

TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, FIRST FLOOR COMMUNICATIONS ROOM, FLOOR PLAN POWER PLAN		
AUTHOR(S)	AFONTCBR SCOTT AFB IL 62225 DSN (314) 775-5695		
FILENAME	C8C-I-CR	SCALE	3/16"=1'
		DATE	17 Sep 2002
		PAGE	1 OF 5





**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown in pages 2 -3 of this drawing. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:

Bay 1: 10,126 BTU/hr  
 Bay 2: 41,080 BTU/hr  
 Bay 3: 23,080 BTU/hr  
 Total: 74,286 BTU/hr

**LEGEND**

Dedicated 20 amp, 120 V, single-phase, three wire circuit terminated to a NEMA 5-20R duplex receptacle



**60% EDR  
Input**



**FOR OFFICIAL USE ONLY**

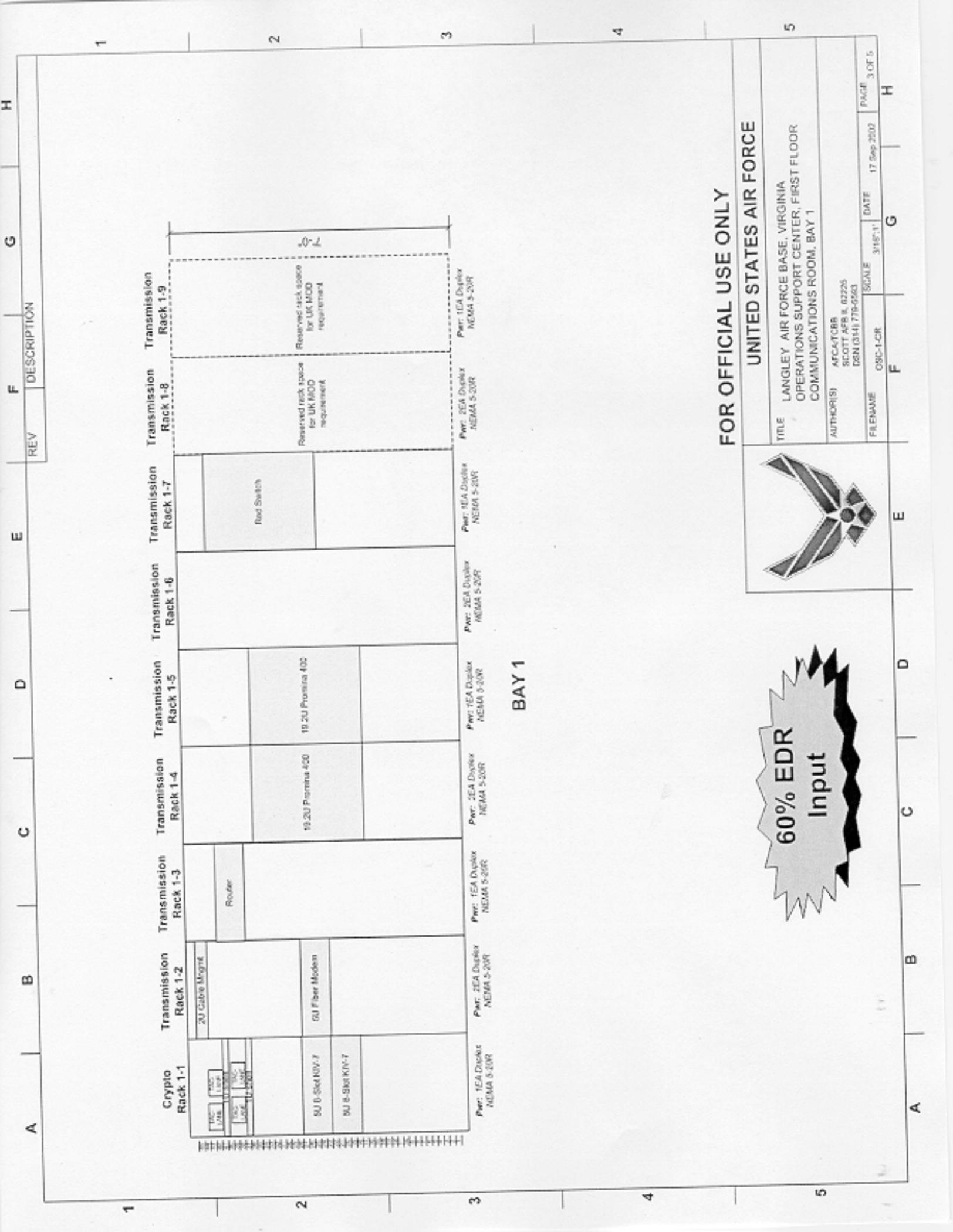
**UNITED STATES AIR FORCE**

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, FIRST FLOOR  
 COMMUNICATIONS ROOM, FLOOR PLAN COMM PLAN

AUTHOR(S): AFGAT08B  
 SCOTT AFB IL 62205  
 DSN (314) 779-5680

FILENAME: OSC-1-CR SCALE: 3/16"=1' DATE: 17 Sep 2002 PAGE: 2 OF 5

REV	DESCRIPTION



REV	DESCRIPTION	F	G	H
1				
2				
3				
4				
5				

SIPRNET Rack 1-10	SIPR Access Rack 1-11	SIPR IP Rack 1-12	SIPR IP Rack 1-13	Spare Rack 1-14	Coalition Rack 1-15	Coalition Rack 1-16	Coalition Rack 1-17	Coalition Rack 1-18
2U Cable Mngmt 2U FO Patch Panel 2U Cable Mngmt	2U Cable Mngmt Ops Spl Cbr Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT 2U Cable Mngmt AOS FO MM 72 PORT	2U Cable Mngmt	2U Cable Mngmt 2U FO Patch Panel	2U Cable Mngmt Ops Spl Cbr Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT
Catalyst 6509 Core/Distro	2U Cable Mngmt C2 Trns Center Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT 2U Cable Mngmt AOS FO MM 72 PORT			2U Cable Mngmt C2 Trns Center Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT
2U Cable Mngmt Catalyst 6509 Core/Distro	2U Cable Mngmt AOS Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT 2U Cable Mngmt AOS FO MM 72 PORT			2U Cable Mngmt AOS Catalyst 4006 Access Switch	2U Cable Mngmt OSC FO MM 72 PORT 2U Cable Mngmt OSC FO MM 72 PORT	2U Cable Mngmt AOS FO MM 72 PORT
2U Cable Mngmt	2U Cable Mngmt Dev Catalyst 4006 Access Switch	2U Cable Mngmt	2U Cable Mngmt			2U Cable Mngmt Dev Catalyst 4006 Access Switch	2U Cable Mngmt Dev FO MM 72 PORT 2U Cable Mngmt Dev FO MM 72 PORT	2U Cable Mngmt Dev FO MM 72 PORT

Pwr: 2EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R

**BAY 2**

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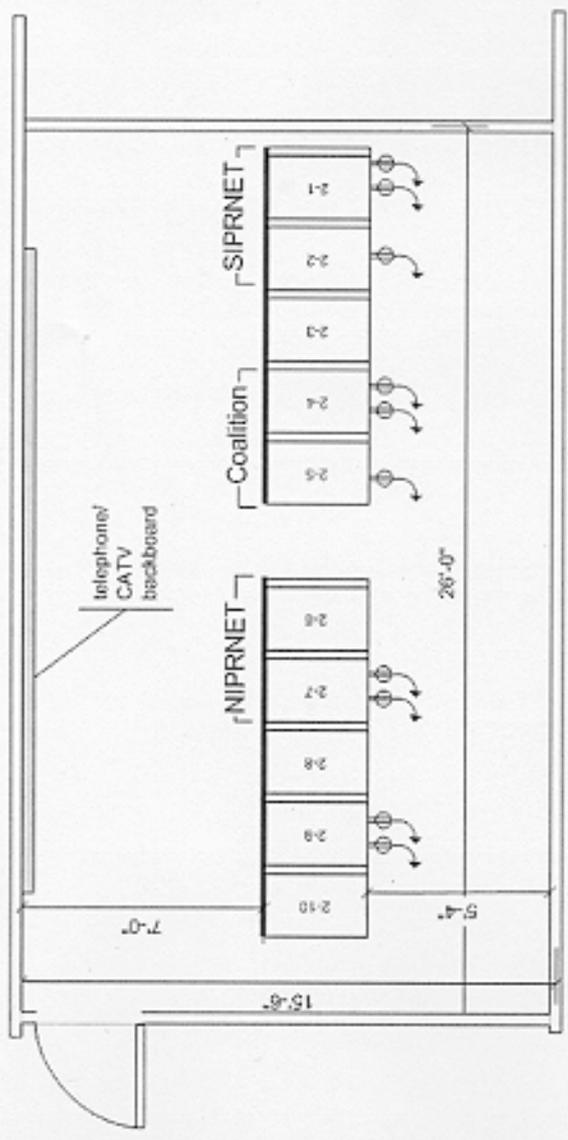
TITLE	UNITED STATES AIR FORCE
AUTHOR(S)	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, FIRST FLOOR COMMUNICATIONS ROOM, BAY 2
FILENAME	AFCATCBB SCOTT AFB IL 62226 DSN (314) 776-6563
SCALE	3/16"=1"
DATE	17 Sep 2002
PAGE	4 OF 5



1  
2  
3  
4  
5

**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown in page 2 of this drawing. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:  
 Bay 1: 14,400 BTU/hr  
 Bay 2: 7,200 BTU/hr  
 Total: 21,600 BTU/hr



**LEGEND**

Dedicated 20 amp, 120 V, single-phase, three wire circuit terminated to a NEMA 5-20R duplex receptacle



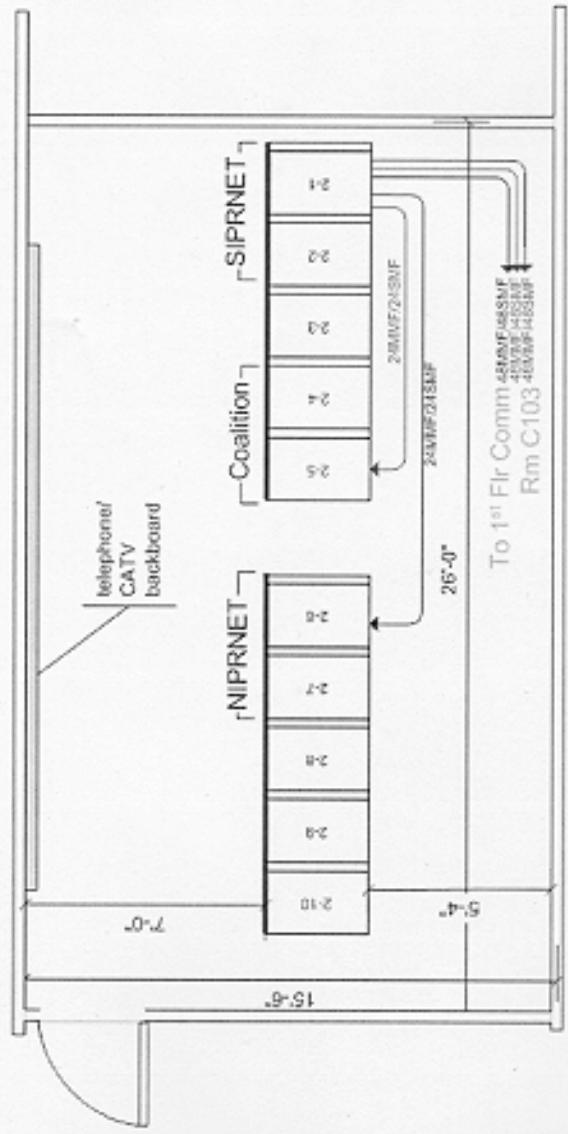
**FOR OFFICIAL USE ONLY**



<b>UNITED STATES AIR FORCE</b>			
TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, SECOND FLOOR COMMUNICATIONS ROOM, FLOOR PLAN POWER PLAN		
AUTHOR(S)	AFCM/CSB SCOTT AFB & 0225 DSN (314) 779-5993		
FILENAME	OSG-2-CR	SCALE	3/16"=1'
		DATE	17 Sep 2002
		PAGE	1 OF 3

**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown in page 2 of this drawing. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:  
 Bay 1: 14,400 BTU/hr  
 Bay 2: 7,200 BTU/hr  
 Total: 21,600 BTU/hr



**FOR OFFICIAL USE ONLY**



**60% EDR  
Input**



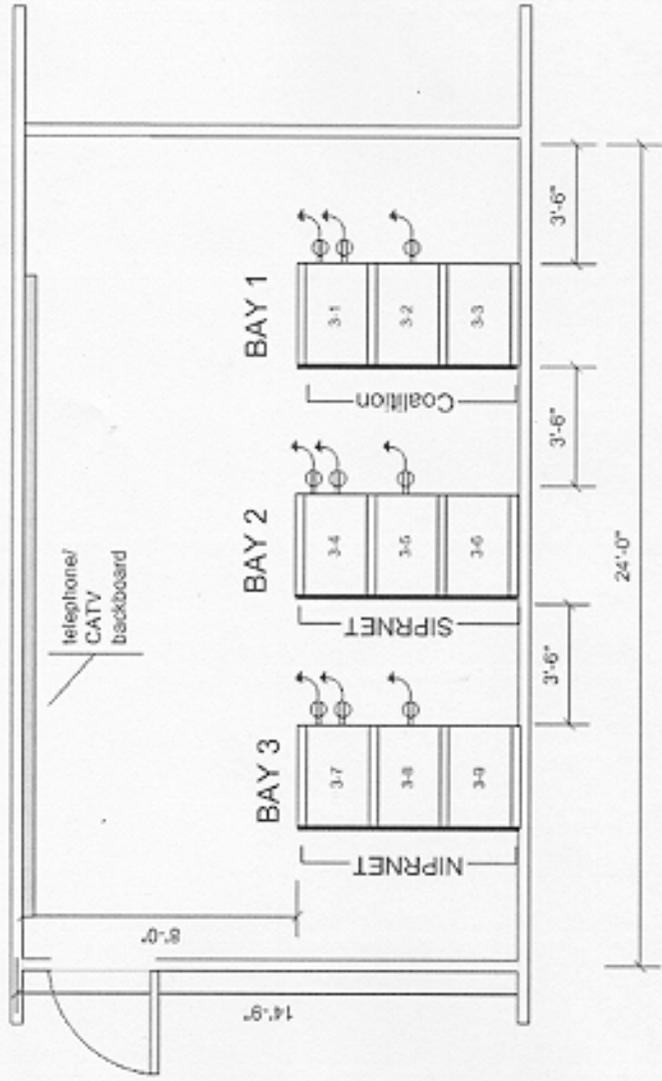
<b>UNITED STATES AIR FORCE</b>			
TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, SECOND FLOOR COMMUNICATIONS ROOM, FLOOR PLAN COMM PLAN		
AUTHOR(S)	AFC/ATC/BI SCOTT AFB IL 62225 DSN 0141 779-5993		
FILENAME	OSC-2-CR	SCALE	3/16"=1'
		DATE	17 Sep 2010
			PAGE 2 OF 3



**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:

Bay 1: 3,600 BTU/hr  
 Bay 2: 3,600 BTU/hr  
 Bay 3: 3,600 BTU/hr  
 Total: 10,800 BTU/hr



**60% EDR  
 Input**



**FOR OFFICIAL USE ONLY**

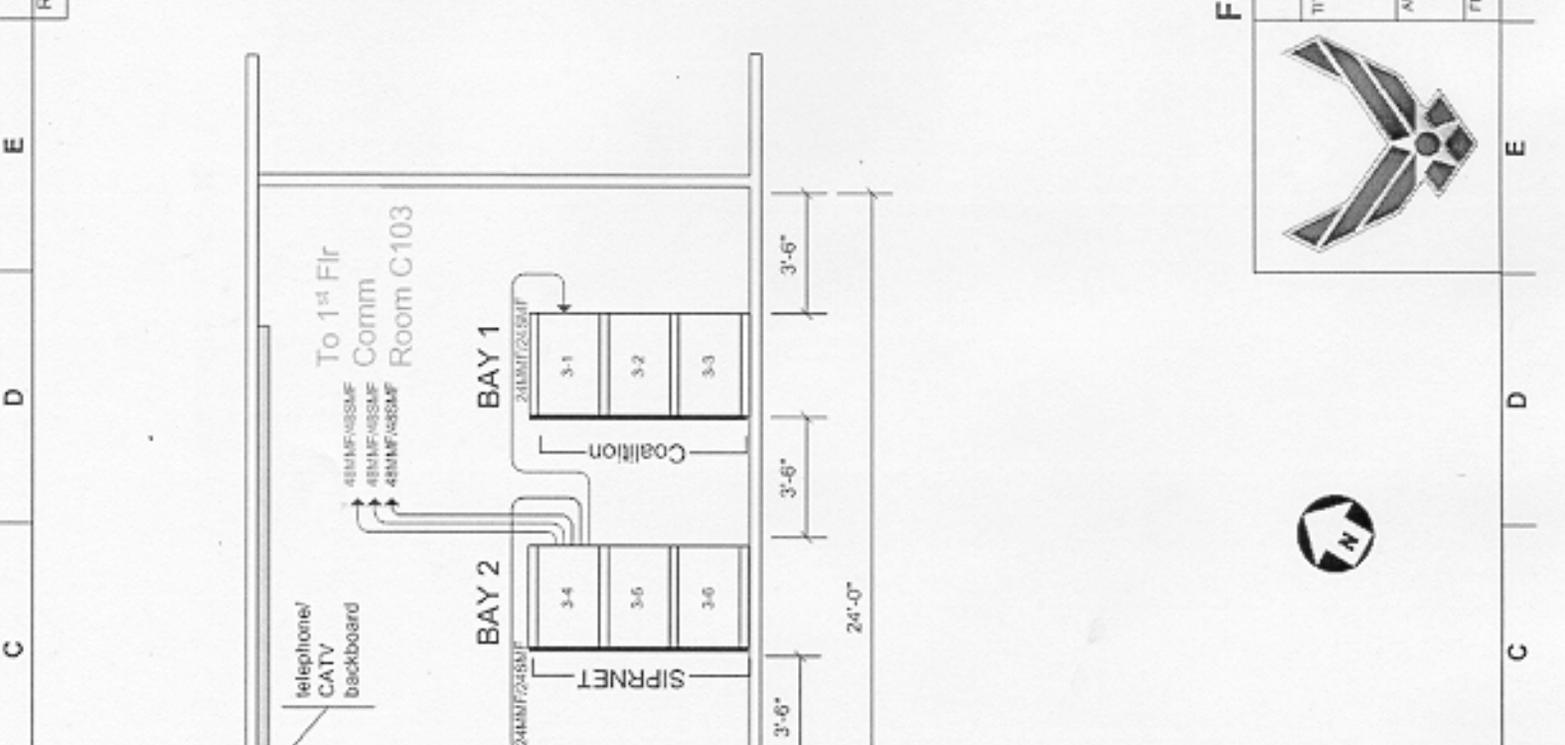
**UNITED STATES AIR FORCE**

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, THIRD FLOOR COMMUNICATIONS ROOM, FLOOR PLAN POWER PLAN			
AUTHOR(S): AFCAVTCMB SCOTT AFB IL 62225 DSN (314) 779-6593			
FILENAME: OSC-3-CR	SCALE: 3/16"=1'	DATE: 17 Sep 2002	PAGE: 1 OF 3



**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:
  - Bay 1: 3,600 BTU/hr
  - Bay 2: 3,600 BTU/hr
  - Bay 3: 3,600 BTU/hr
  - Total: 10,800 BTU/hr



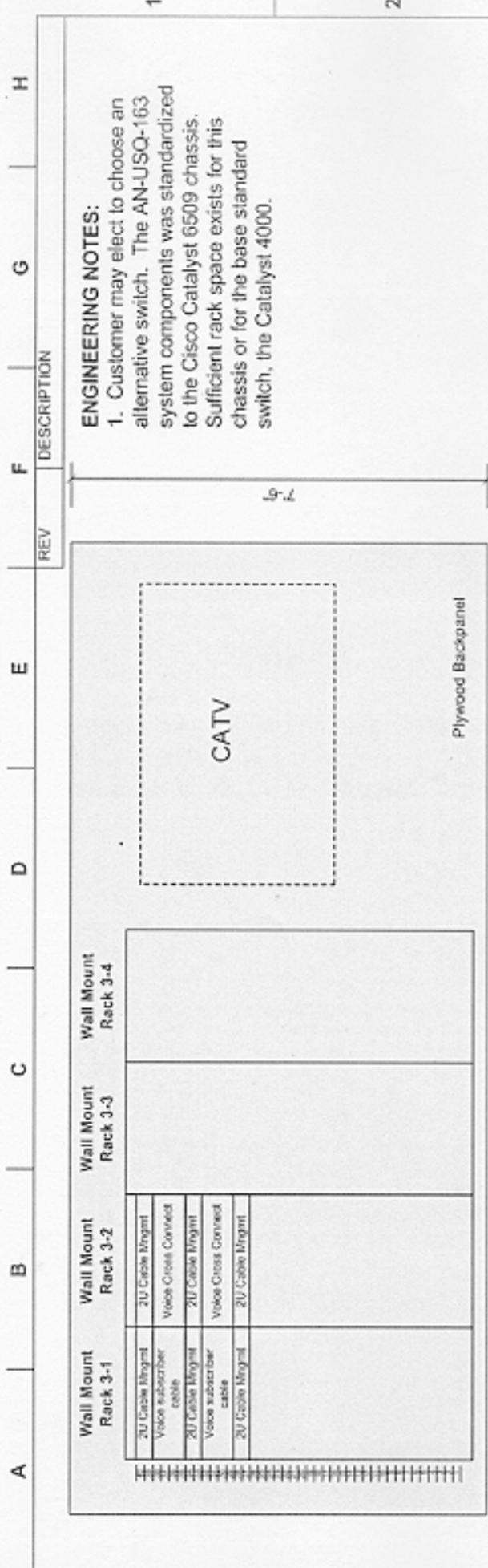
**FOR OFFICIAL USE ONLY**

**UNITED STATES AIR FORCE**

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, THIRD FLOOR  
 COMMUNICATIONS ROOM, FLOOR PLAN COMM PLAN

AUTHOR(S): AFD/ATC/SS  
 SCOTT AFB IL 62225  
 DSN (314) 779-5593

FILENAME: OSC-3-CR SCALE: 3/16"=1' DATE: 17 Sep 2002 PAGE: 2 OF 3



**ENGINEERING NOTES:**

- Customer may elect to choose an alternative switch. The AN-USQ-163 system components was standardized to the Cisco Catalyst 6509 chassis. Sufficient rack space exists for this chassis or for the base standard switch, the Catalyst 4000.

Coalition Rack 3-1	Coalition Rack 3-2	Spare Rack 3-3	FOOP SIPR IP Rack 3-4	SIPRNET Rack 3-5	Spare Rack 3-6	NIPR Inside Plant Rack 3-7	NIPR Rack 3-8	Rack 3-9
2U Cable Mgmt 2U FO Patch Panel Catalyst 4006 Access Switch 2U Cable Mgmt	2U Cable Mgmt 144 MMF Data 2U Cable Mgmt 144 MMF Data 2U Cable Mgmt	2U Cable Mgmt 144 MMF Data 2U Cable Mgmt 144 MMF Data 2U Cable Mgmt	2U Cable Mgmt 48 MMF488MF Riser 2U Cable Mgmt Catalyst 4006 Access Switch 2U Cable Mgmt	2U Cable Mgmt FO MM Data 2U Cable Mgmt FO MM Data 144MMF 2U Cable Mgmt	2U Cable Mgmt FO MM Data 2U Cable Mgmt FO MM Data 144MMF 2U Cable Mgmt	2U Cable Mgmt 2U FO Patch Panel 2U Cable Mgmt Catalyst 4006 Access Switch 2U Cable Mgmt	2U Cable Mgmt NIPR Cat Se Data 96 port 2U Cable Mgmt NIPR Cat Se Data 96 port 2U Cable Mgmt	2U Cable Mgmt

Pwr: 2EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R

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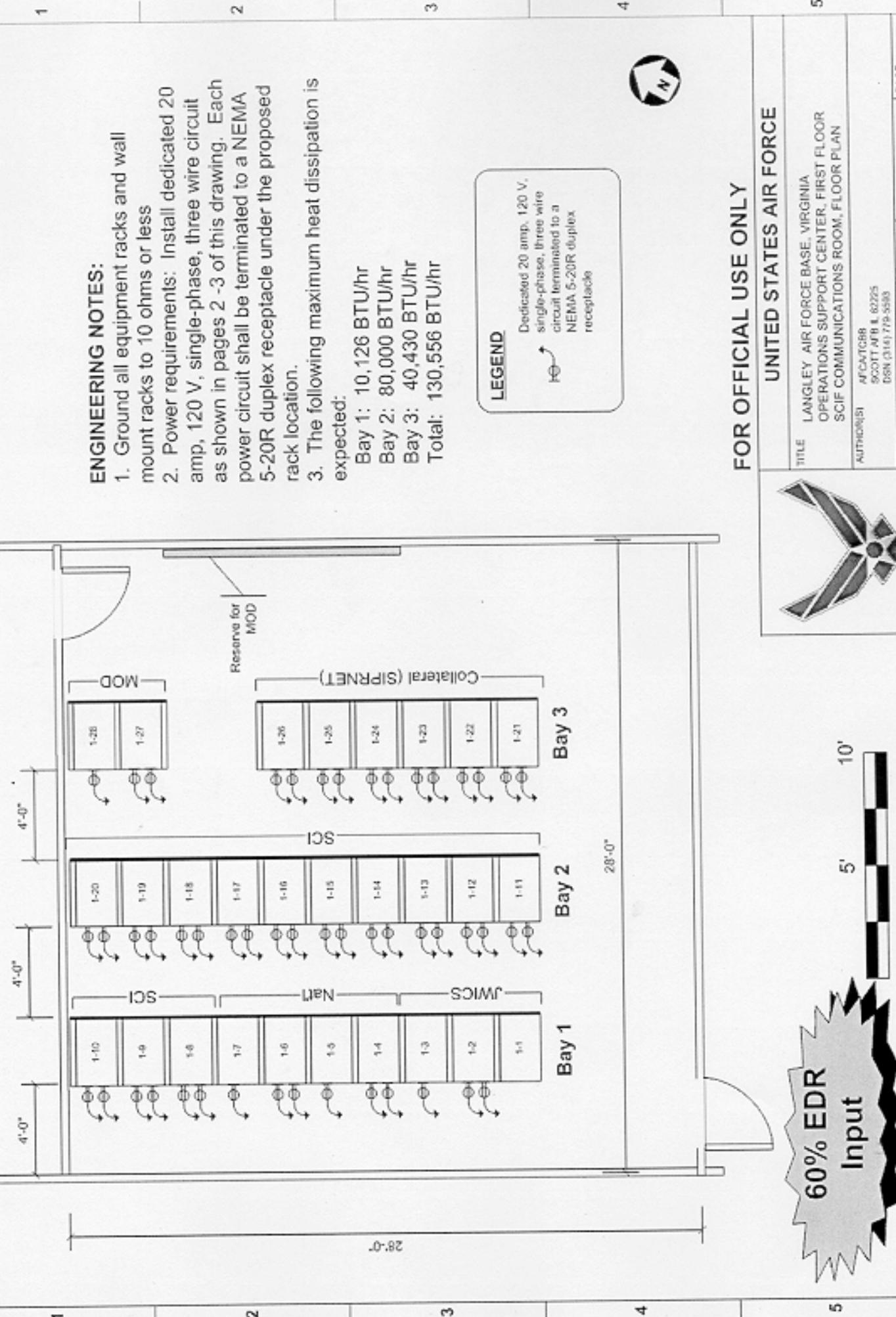
**UNITED STATES AIR FORCE**

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, THIRD FLOOR COMMUNICATIONS ROOM, FACE EQUIPMENT

AUTHOR(S): AFCAT/CRB SCOTT/AFB IL 62226 DSN (316) 775-6699

FILENAME: OSC-3-CR SCALE: 3/8"=1' DATE: 17 Sep 2002 PAGE: 3 OF 3





**ENGINEERING NOTES:**

1. Ground all equipment racks and wall mount racks to 10 ohms or less
2. Power requirements: Install dedicated 20 amp, 120 V, single-phase, three wire circuit as shown in pages 2 -3 of this drawing. Each power circuit shall be terminated to a NEMA 5-20R duplex receptacle under the proposed rack location.
3. The following maximum heat dissipation is expected:

Bay 1: 10,126 BTU/hr  
 Bay 2: 80,000 BTU/hr  
 Bay 3: 40,430 BTU/hr  
 Total: 130,556 BTU/hr

**LEGEND**

Dedicated 20 amp, 120 V, single-phase, three wire circuit terminated to a NEMA 5-20R duplex receptacle

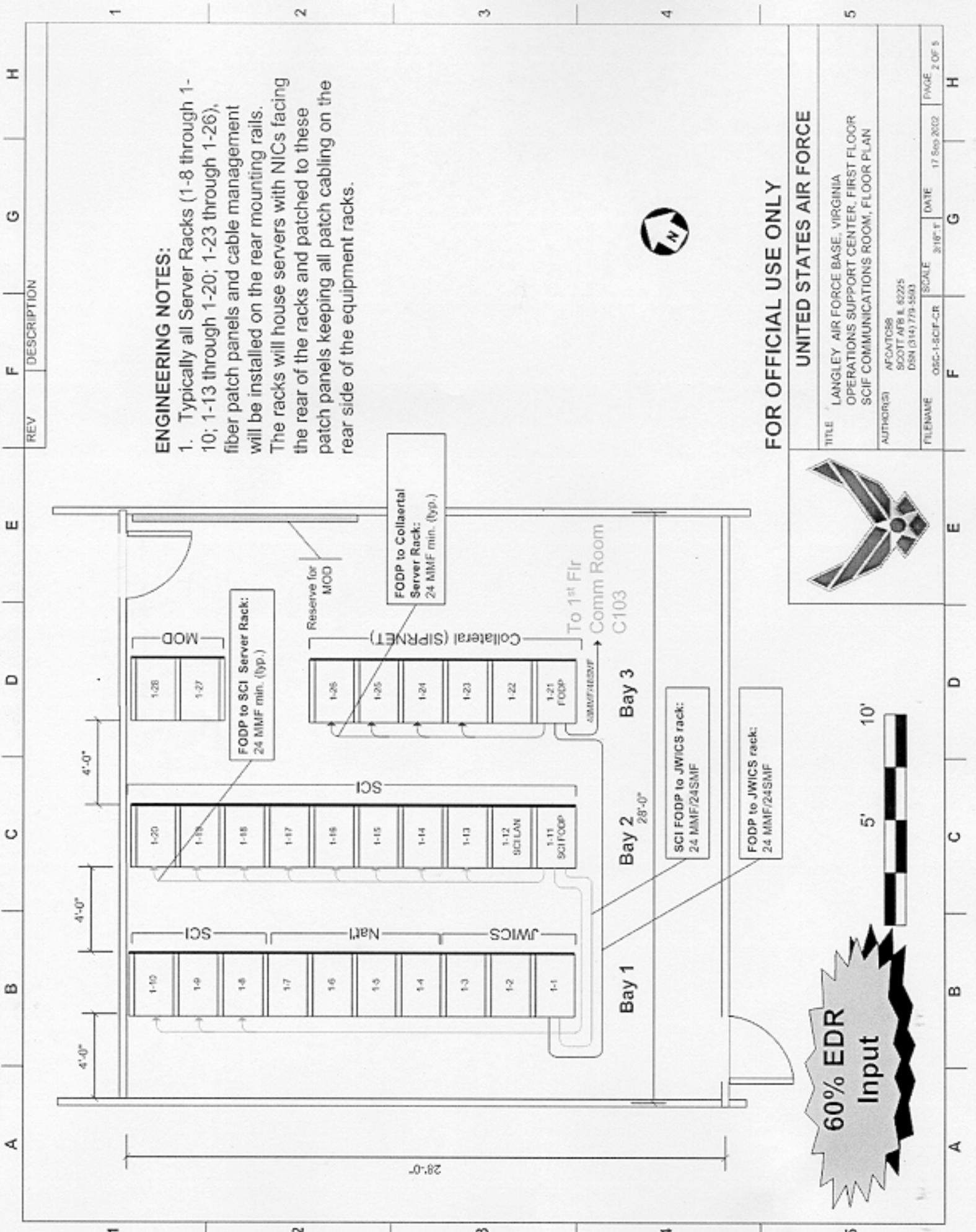


**FOR OFFICIAL USE ONLY**

**UNITED STATES AIR FORCE**

TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, FIRST FLOOR SCIF COMMUNICATIONS ROOM, FLOOR PLAN		
AUTHOR/ISSI	AFCATGRR	SCOTT AFR 3, 60225	OSR (314) 779-5588
FILENAME	OSG-1-SCIF-CR	SCALE	3/16" = 1'
		DATE	17 Sep 2002
		PAGE	1 OF 3





**ENGINEERING NOTES:**

- Typically all Server Racks (1-8 through 1-10; 1-13 through 1-20; 1-23 through 1-26), fiber patch panels and cable management will be installed on the rear mounting rails. The racks will house servers with NICs facing the rear of the racks and patched to these patch panels keeping all patch cabling on the rear side of the equipment racks.

REV	DESCRIPTION

**FOR OFFICIAL USE ONLY**

**UNITED STATES AIR FORCE**

TITLE LANGLEY AIR FORCE BASE, VIRGINIA  
OPERATIONS SUPPORT CENTER, FIRST FLOOR  
SCIF COMMUNICATIONS ROOM, FLOOR PLAN

AUTHOR(S) AFC/ATC88  
SCOTT AFB IL 62225  
DSN (314) 779-5503

FILENAME OSC-1-SCIF-CR SCALE 3/16"=1' DATE 17 Sep 2002 PAGE 2 OF 3



REV DESCRIPTION

Inside Plant FO Rack 1-1	JWICS LAN Rack 1-2	Transmission Rack 1-3	Nat'l Rack 1-4	Nat'l Rack 1-5	Nat'l Rack 1-6	Nat'l Rack 1-7	SCI Rack 1-8	SCI Rack 1-9	SCI Rack 1-10
2U Cable Mgmt 46 MMF/SSMF Riser 2U Cable Mgmt		2U Cable Mgmt 19.2U Promina 400	19.2U Promina 400	Nat'l LAN & Voice	Nat'l LAN & Voice	Nat'l LAN & Voice	2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt

7-0

Pwr: 1EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R Pwr: 1EA Duplex NEMA 5-20R Pwr: 2EA Duplex NEMA 5-20R

BAY 1



FOR OFFICIAL USE ONLY

UNITED STATES AIR FORCE

TITLE LANGLEY AIR FORCE BASE, VIRGINIA  
OPERATIONS SUPPORT CENTER, FIRST FLOOR  
SCIF COMM ROOM, BAY 1, FACE EQUIPMENT

AUTHOR(S) AF/CV/CSSB  
SCOTT AFB IL 62275  
DSN (314) 779-5993

FILENAME CSC-1-SCF-CR SCALE 3/8"=1' DATE 17 Sep 2002 PAGE 3 OF 5

REV	DESCRIPTION	F	G	H
1				
2				
3				
4				
5				

A	B	C	D	E	F	G	H			
1	SCI Rack 1-11 2U Cable Mgmt 4U 144 MMF 2U Cable Mgmt 4U 144 MMF SCF Inside Plant 2U Cable Mgmt 4U 144 MMF SCF Inside Plant 2U Cable Mgmt 4U 144 MMF to server racks 2U Cable Mgmt 4U 144 MMF to server racks 2U Cable Mgmt	SCI Rack 1-12 2U Cable Mgmt Catalyst 4006 Access Switch 2U Cable Mgmt Catalyst 4006 Access Switch Router 2U Cable Mgmt	SCI Rack 1-13 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-14 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-15 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-16 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-17 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-18 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-19 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt	SCI Rack 1-20 2U Cable Mgmt 2U MMF patch panel 2U Cable Mgmt
2										
3										
4										
5										

7'-0"

BAY 2

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 UNITED STATES AIR FORCE



60% EDR  
 Input

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, FIRST FLOOR  
 SCIF COMM ROOM, BAY 2, FACE EQUIPMENT  
 AUTHOR(S): AFGA/TCBB  
 SCOTT AFB IL 60225  
 DSM (14) 775-5593  
 FILENAME: OSC-1-SCF-CR  
 SCALE: 3/8"=1'  
 DATE: 17 Sep 2002  
 PAGE: 4 OF 5

REV DESCRIPTION

Plywood Backpanel  
Reserved for MOD

Collateral Rack 1-19	Collateral Rack 1-20	Collateral Rack 1-21	Collateral Rack 1-22	Collateral Rack 1-23	Collateral Rack 1-24
2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt
4U MMF patch panel	2U MMF patch panel	2U MMF patch panel	2U MMF patch panel	2U MMF patch panel	2U MMF patch panel
2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt	2U Cable Mgmt
4U SMF patch panel					
2U Cable Mgmt					
Catalyst 4006 Access Switch					

Pwr: 2EA Duplex NEMA 5-20R  
 Pwr: 2EA Duplex NEMA 5-20R

BAY 3

**60% EDR**  
Input



FOR OFFICIAL USE ONLY

UNITED STATES AIR FORCE

TITLE LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, FIRST FLOOR  
 SCIF COMM ROOM, BAY 3, FACE EQUIPMENT

AUTHOR(S) AFCAITCSB  
 SCOTT AFB IL 62226  
 DSN (314) 779-5593

FILENAME CSC-1-SCIF-CR SCALE 3/8"=1" DATE 17 Sep 2002 PAGE 9 OF 9

A B C D E F G H

1 2 3 4 5

1 2 3 4 5

A B C D E F G H

REV DESCRIPTION

Plywood Backpanel  
Reserved for MOD

7'-0"

Collateral Rack 1-19	Collateral Rack 1-20	Collateral Rack 1-21	Collateral Rack 1-22	Collateral Rack 1-23	Collateral Rack 1-24
2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt
4U MAF patch panel	2U MRF patch panel	2U MRF patch panel	2U MRF patch panel	2U MRF patch panel	2U MRF patch panel
2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt	2U Cabinet Mgmt
4U SMF patch panel					
2U Cabinet Mgmt					
Catalyst HDS Access Switch					

MOD Rack 1-26	MOD Rack 1-27

7'-0"

Part: 2EA Duplex  
NEMA 5-20R

Part: 1CA Duplex  
NEMA 5-20R

Part: 2EA Duplex  
NEMA 5-20R

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**BAY 3**

**UNITED STATES AIR FORCE**



**60% EDR  
Input**

TITLE LANGLEY AIR FORCE BASE, VIRGINIA  
OPERATIONS SUPPORT CENTER, FIRST FLOOR  
SCIF COMM ROOM, BAY 3, FACE EQUIPMENT

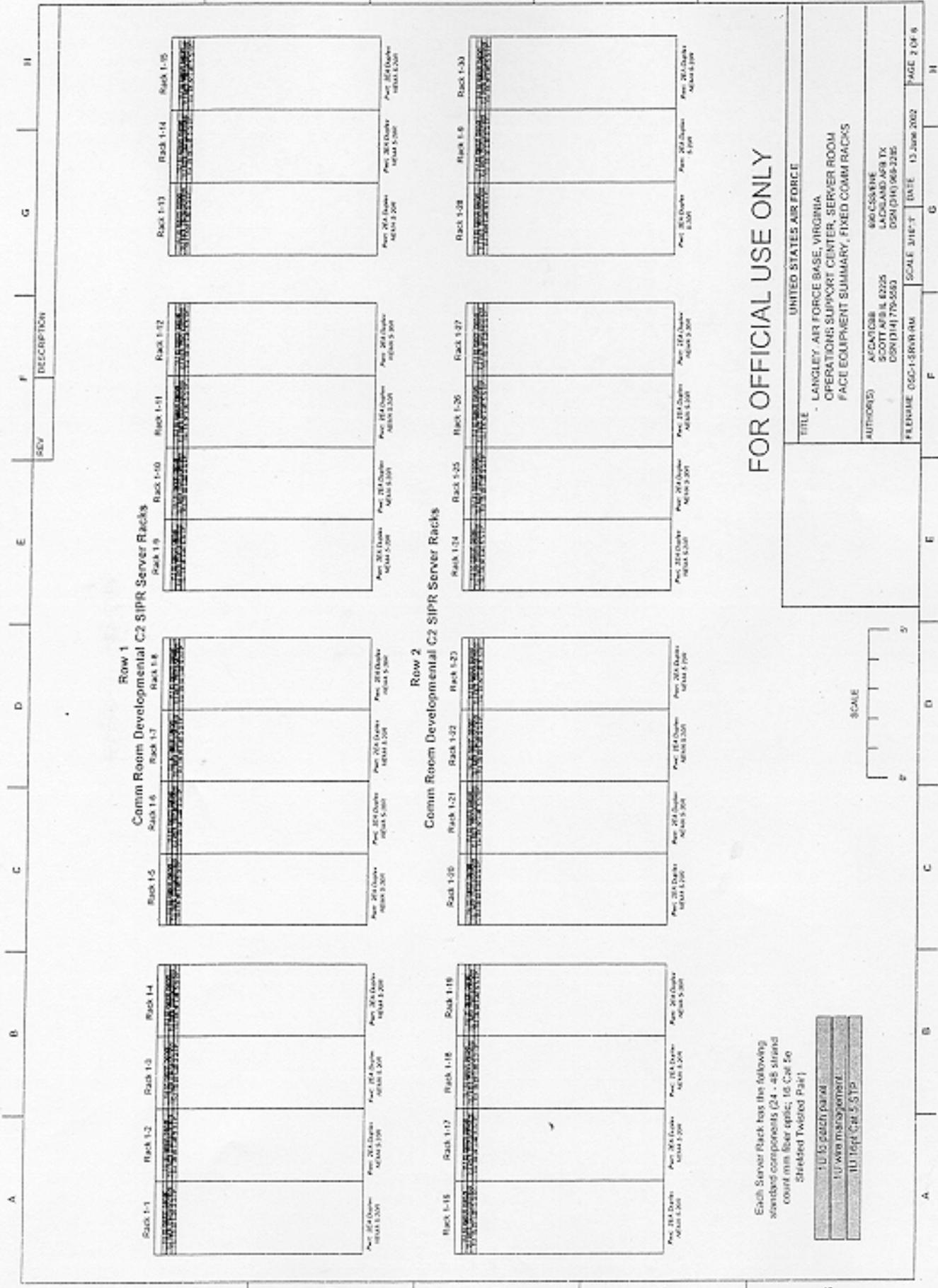
AUTHOR(S) AECAT/CBB  
SCOTT AFB IL 62225  
DSN (314) 779-5993

FILENAME C8C-1-SCIF-CR SCALE 3/8"=1' DATE 17-Sep-2002 PAGE 5 OF 8

1 2 3 4 5

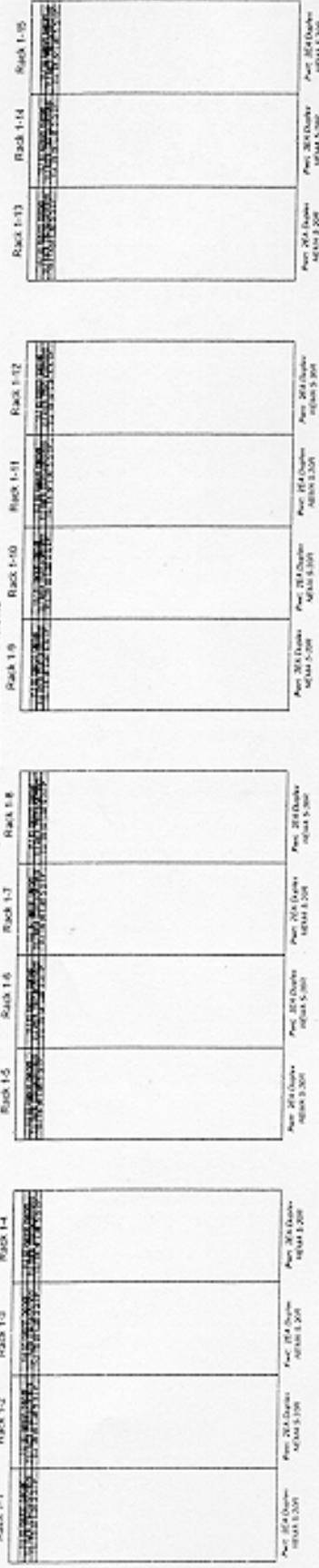
A B C D E F G H



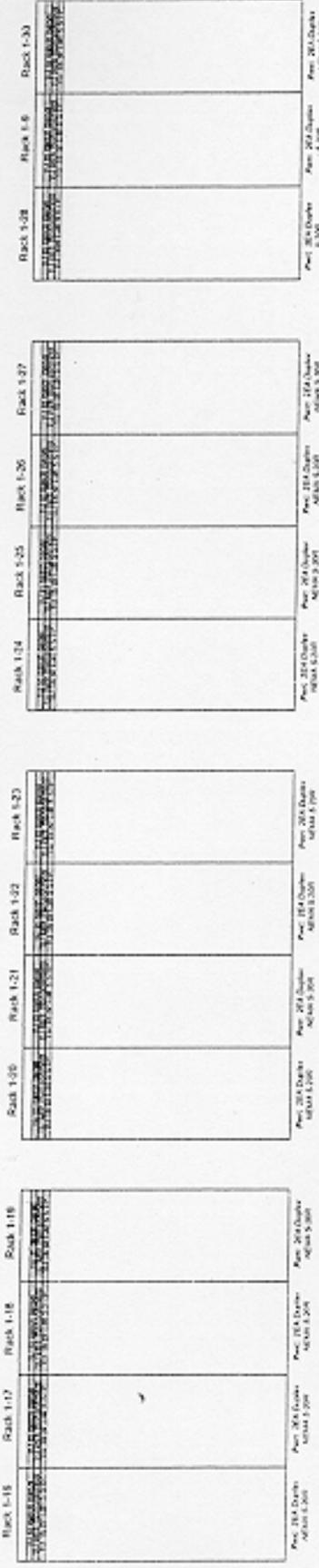


REV	DESCRIPTION

Row 1  
Comm Room Developmental C2 SIPR Server Racks



Row 2  
Comm Room Developmental C2 SIPR Server Racks



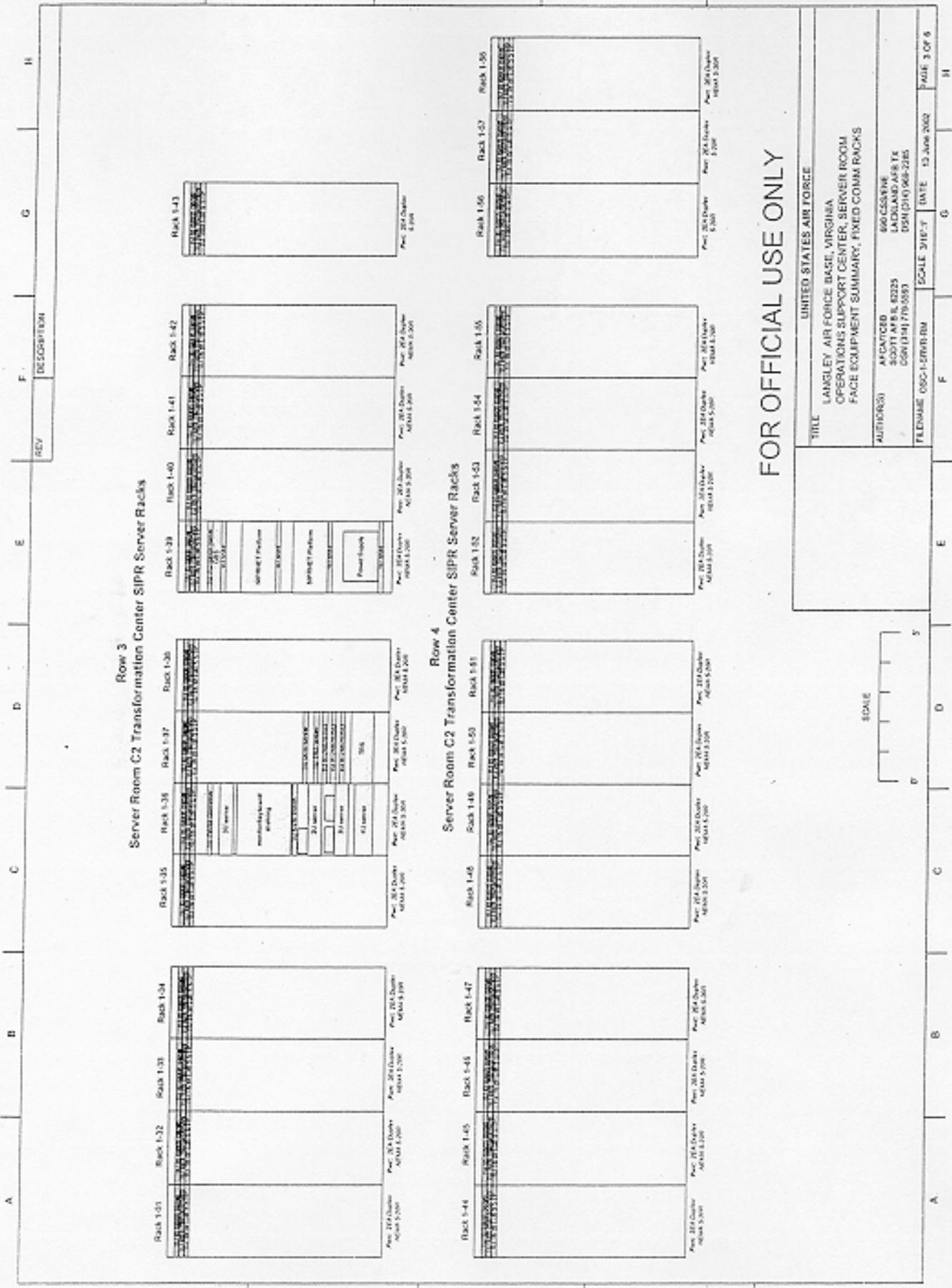
Each Server Rack has the following standard components (24 - 48 strand count min fiber optic; 16 Cat 5e Shielded Twisted Pair)

- 1U 15 patch panel
- 1U wire management
- 1U 10pt Cat 5 UTP



FOR OFFICIAL USE ONLY

TITLE		UNITED STATES AIR FORCE	
AUTHOR(S)		LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, SERVER ROOM FACE EQUIPMENT SUMMARY, FIXED COMM RACKS	
FILENAME		DSC1141779-535	
DATE		13 June 2002	
SCALE		1:1	
PAGE		2 OF 6	



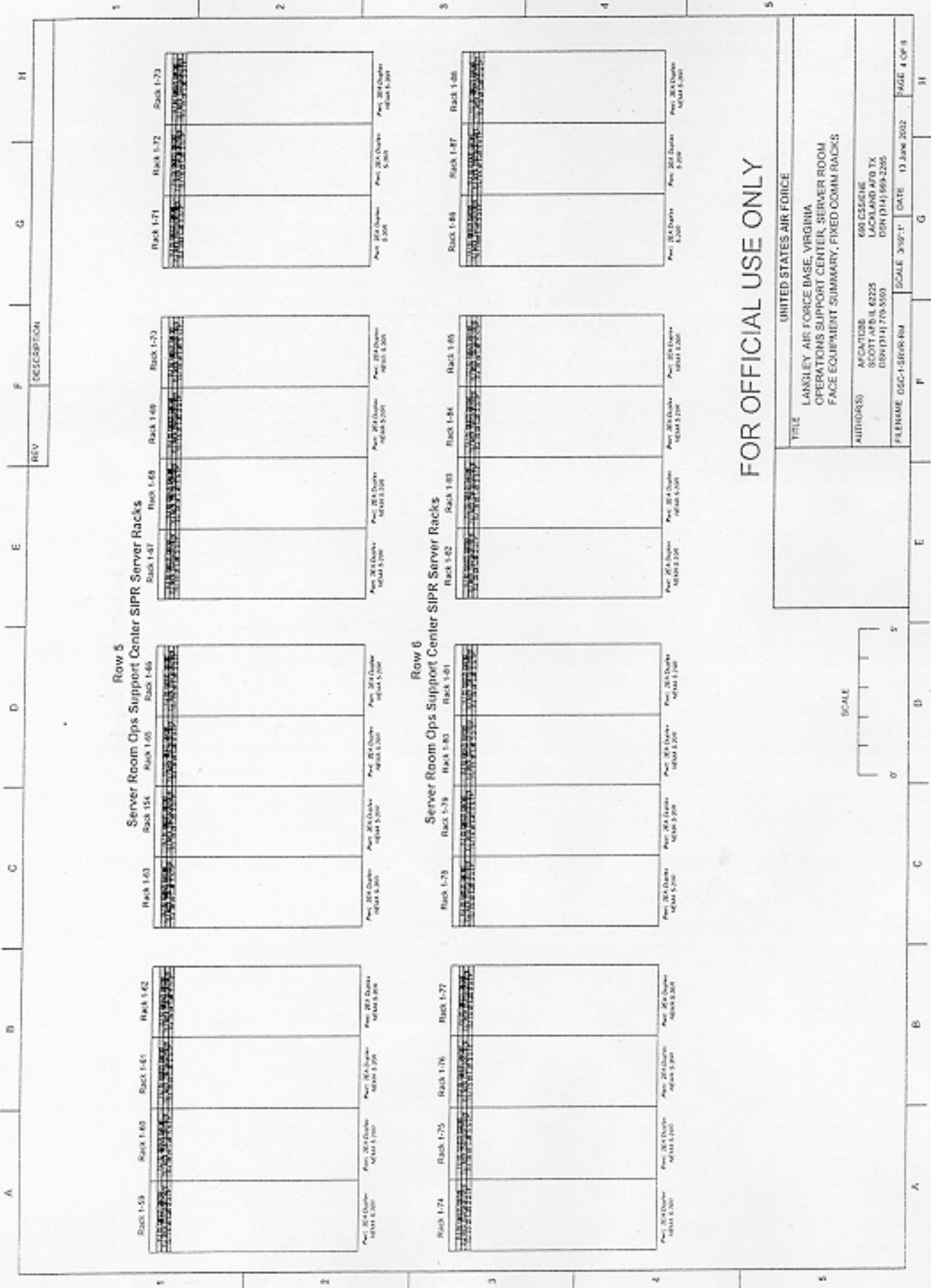
Row 3  
Server Room C2 Transformation Center SIPR Server Racks

Row 4  
Server Room C2 Transformation Center SIPR Server Racks

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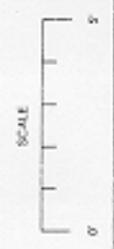
UNITED STATES AIR FORCE	
TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, SERVER ROOM FACE EQUIPMENT SUMMARY, FIXED COMM RACKS
AUTHOR(S)	AF/AVICED SCOTT AFRL 8225 CON/141/770-555
FILENAME	0502-1-570-R01
SCALE	3/16"=1'
DATE	13 June 2002
PAGE 3 OF 6	





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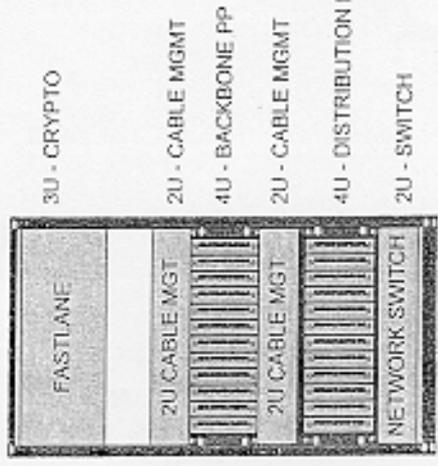
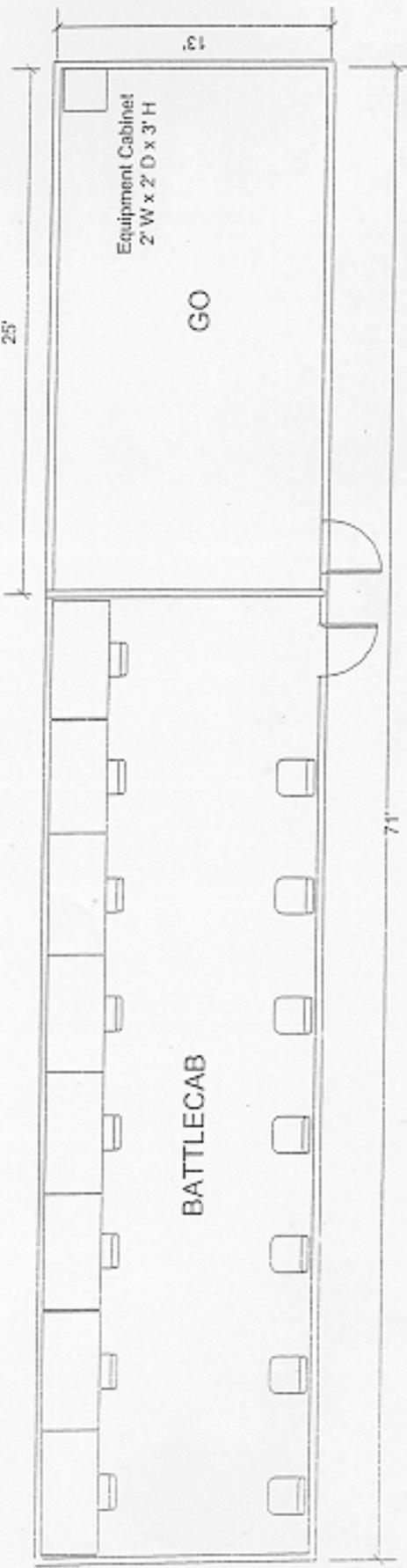
TITLE		UNITED STATES AIR FORCE	
LANGLEY AIR FORCE BASE, VIRGINIA			
OPERATIONS SUPPORT CENTER, SERVER ROOM			
FACE EQUIPMENT SUMMARY, FIXED COMM RACKS			
AUTHOR(S)	AFCA/TDSB	690 C55616	
	SCOTT AFB IL 6225	LACLAND AFB TX	
	DSN (DIA) 779-5593	DSN (DIA) 969-2285	
FRENAME	DSG-1-SIPR-RM	SCALE	3/8"=1'
		DATE	13 Jun 2022
			PAGE 1 OF 3







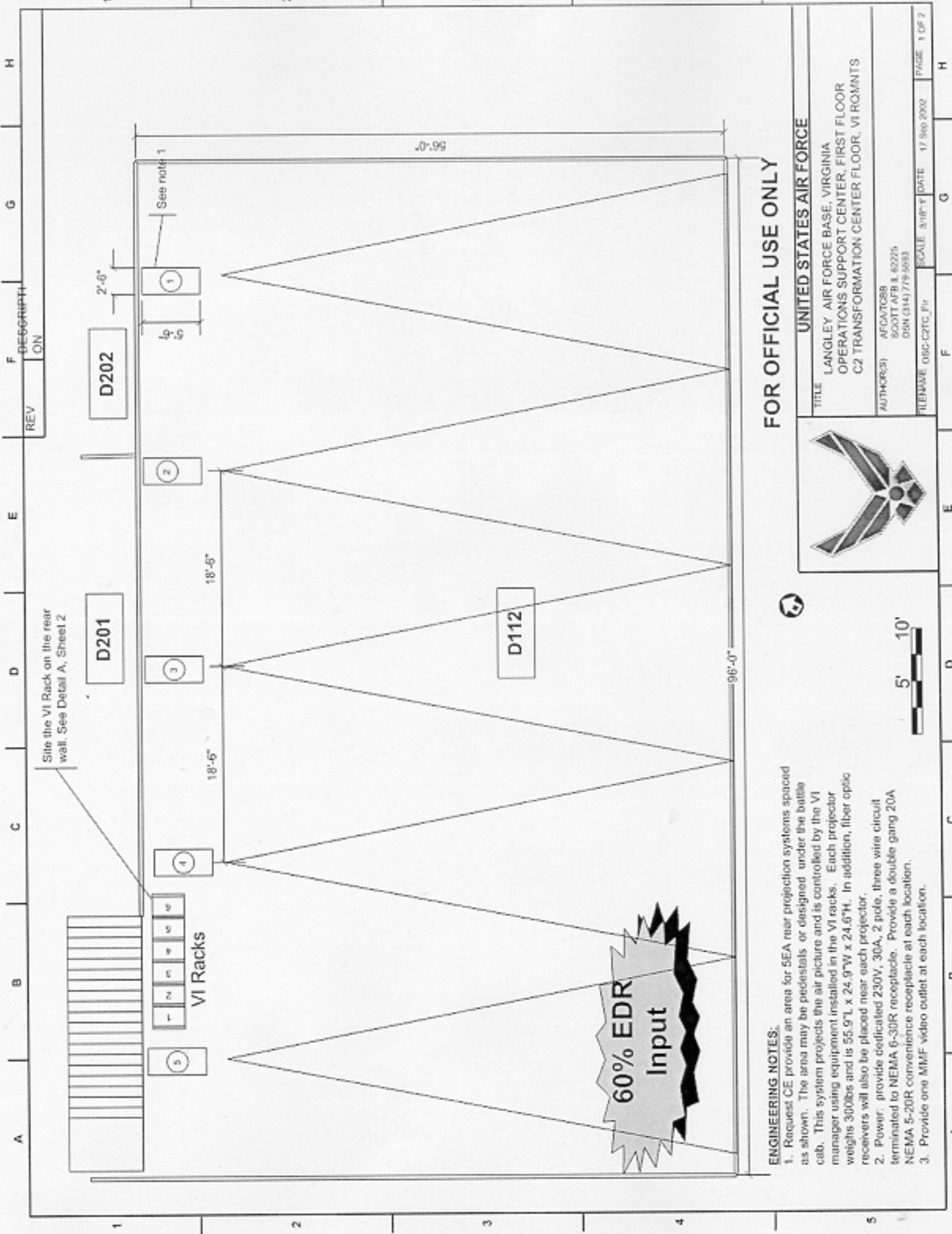
REV	DESCRIPTION



**FOR OFFICIAL USE ONLY**

- ENGINEERING NOTES:**
1. Equipment Rack not to scale.
  2. Equipment provides JWICS or other SCI Network Access.
  3. Configuration for both Battlecabs is the same.

<b>TITLE</b> UNITED STATES AIR FORCE LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER FLOOR BOX CONFIGURATIONS	
<b>AUTHOR(S)</b> AFCAT/CHH SCOTT AFB IL 62225 DSN (314) 779-5580	690 CSS/ENE LACKLAND AFB TX DSN (314) 969-2285
<b>FILENAME</b> WIREMOLD	<b>SCALE</b> 1/8" = 1' <b>DATE</b> 14 June 02



**ENGINEERING NOTES:**

1. Request CE provide an area for SEA near projection systems spaced as shown. The area may be pedestals or designed under the battle cab. This system projects the air picture and is controlled by the VI manager using equipment installed in the VI racks. Each projector weighs 300lbs and is 55.9"L x 24.9"W x 24.6"H. In addition, fiber optic receivers will also be placed near each projector.
2. Power: provide dedicated 230V, 30A, 2 pole, three wire circuit terminated to NEMA 6-30R receptacle. Provide a double gang 20A NEMA 5-20R convenience receptacle at each location.
3. Provide one MMF video outlet at each location.



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**UNITED STATES AIR FORCE**

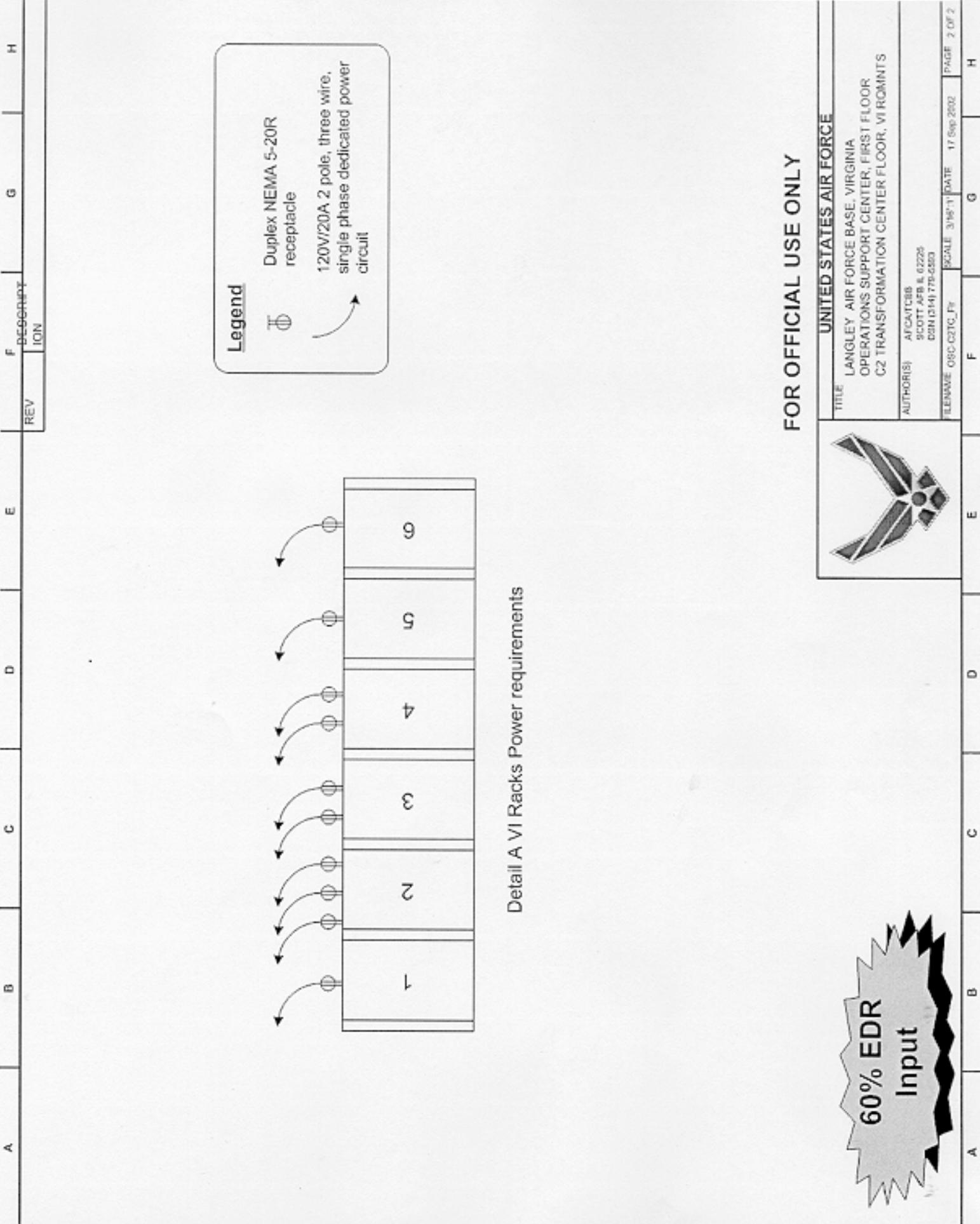
TITLE  
 LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, FIRST FLOOR  
 C2 TRANSFORMATION CENTER FLOOR, VI ROOMS

AUTHOR(S)  
 AFCATC88  
 SCOTT AFB IL 62229  
 DBN (314) 719-5593

FILENAME: 06C-C2TC\_F11 SCALE: 3/16"=1' DATE: 17 Sep 2002 PAGE: 1 OF 2

REV	DESCRIPTION

1 2 3 4 5



Detail A VI Racks Power requirements

REV	DESCRIPTION

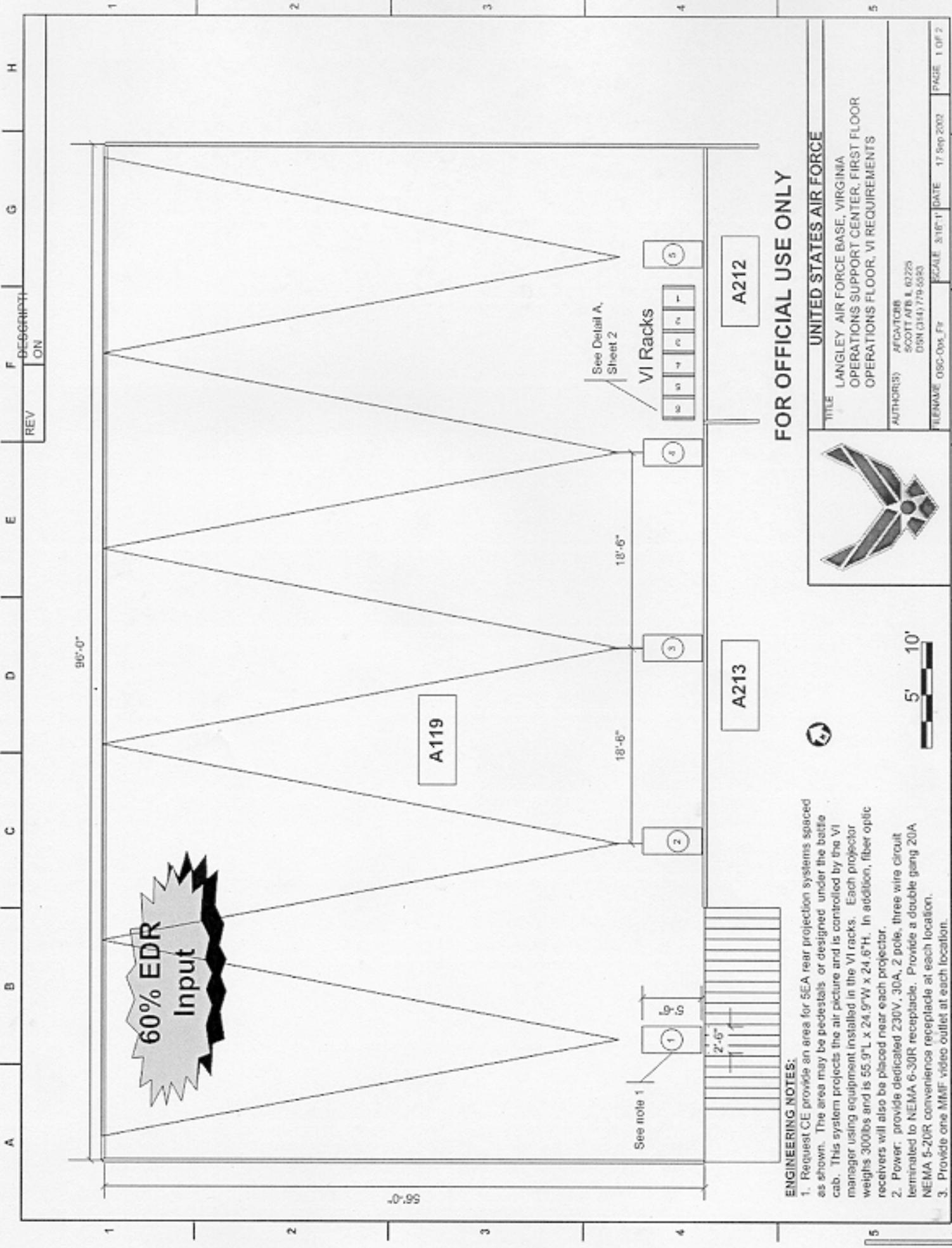


FOR OFFICIAL USE ONLY



<b>UNITED STATES AIR FORCE</b>	
TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, FIRST FLOOR C2 TRANSFORMATION CENTER FLOOR, VI ROOMTS
AUTHOR(S)	AFCAT/CBS SCOTT AFB IL 62225 D3N (314) 775-0250
FILENAME	OSC-C2TC_F1
SCALE	3/16"=1'
DATE	17 Sep 2002
PAGE	2 OF 2

A B C D E F G H



REV	DESCRIPTION

**FOR OFFICIAL USE ONLY**



**UNITED STATES AIR FORCE**  
 TITLE: LANGLEY AIR FORCE BASE, VIRGINIA  
 OPERATIONS SUPPORT CENTER, FIRST FLOOR  
 OPERATIONS FLOOR, VI REQUIREMENTS  
 AUTHOR(S): AFDCA/TORR  
 SCOTT AFB IL 62229  
 DSN (314) 779-5930  
 FILENAME: OSC-004\_Fr SCALE: 3/16"=1' DATE: 17 Sep 2002 PAGE: 1 OF 2

**ENGINEERING NOTES:**

1. Request CE provide an area for SEA rear projection systems spaced as shown. The area may be pedestals or designed under the battle cab. This system projects the air picture and is controlled by the VI manager using equipment installed in the VI racks. Each projector weighs 300lbs and is 55.9"L x 24.9"W x 24.6"H. In addition, fiber optic receivers will also be placed near each projector.
2. Power: provide dedicated 230V, 30A, 2 pole, three wire circuit terminated to NEMA 6-30R receptacle. Provide a double gang 20A NEMA 5-20R convenience receptacle at each location.
3. Provide one MMF video outlet at each location.



-0.99

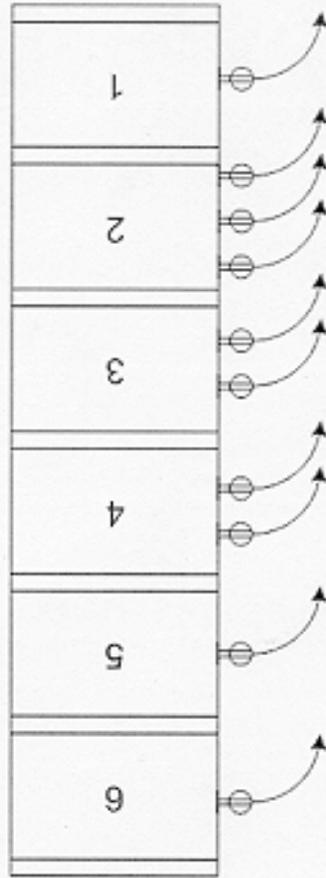
**Legend**



Duplex NEMA 5-20R receptacle



120V/20A 2 pole, three wire, single phase dedicated power circuit



Detail A VI Racks Power requirements



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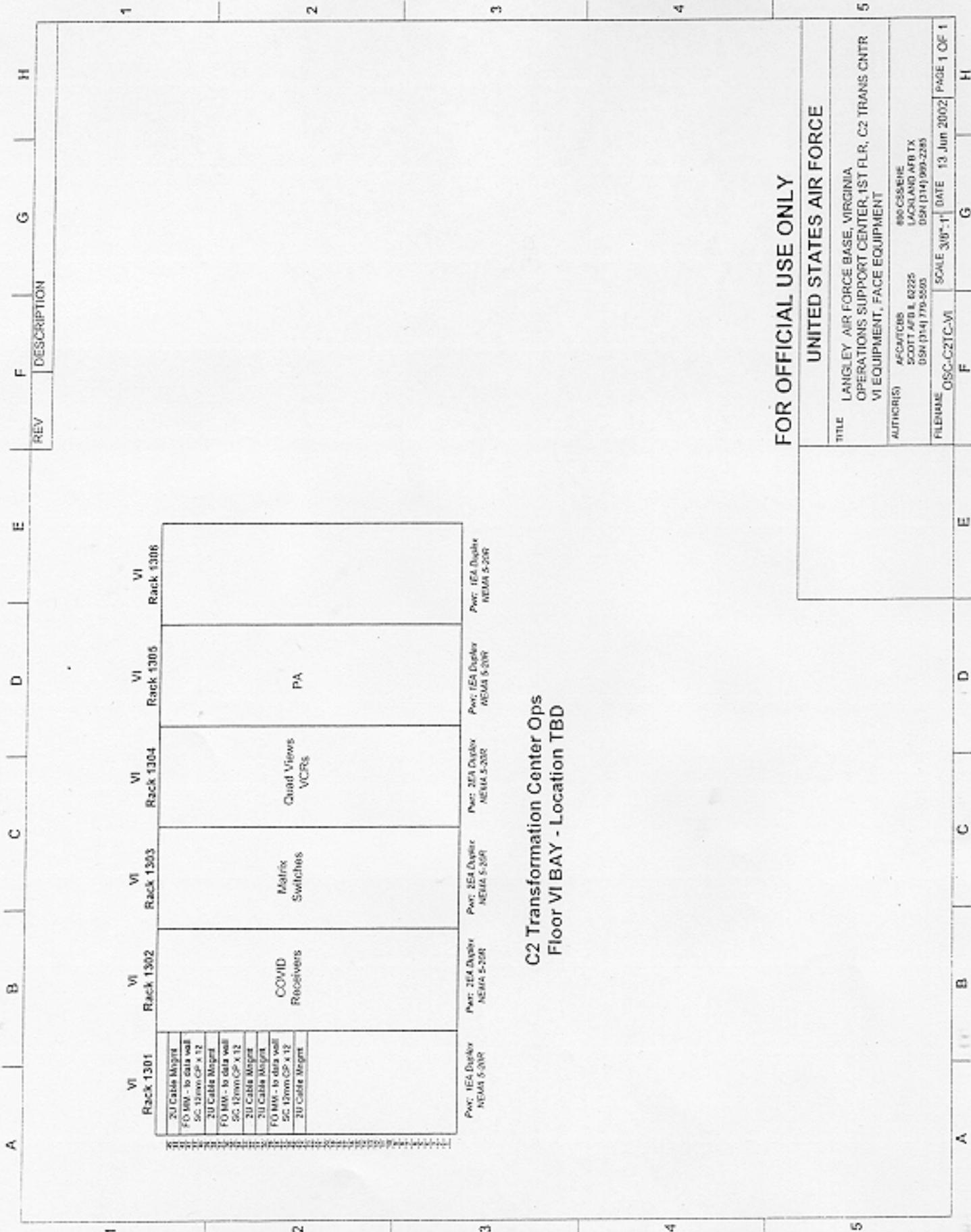


**UNITED STATES AIR FORCE**

TITLE: LANGLEY AIR FORCE BASE, VIRGINIA, OPERATIONS SUPPORT CENTER, FIRST FLOOR OPERATIONS FLOOR, VI REQUIREMENTS

AUTHOR(S): AFCA/CS8  
SCOTT AFB IL 62225  
DSN (314) 776-5553

FILENAME: CSC-Opn\_Pv SCALE: 3/16"=1' DATE: 17 Sep 2002 PAGE: 2 OF 2



VI Rack 1301	VI Rack 1302	VI Rack 1303	VI Rack 1304	VI Rack 1305	VI Rack 1306
24 Cable Mgmt FO MM - to data wall SC 10mm CP x 12 20 Cable Mgmt FO MM - to data wall SC 12mm CP x 12 20 Cable Mgmt 30 Cable Mgmt FO MM - to data wall SC 10mm CP x 12 20 Cable Mgmt	COVID Receivers	Matrix Switches	Quad Views VCERS	PA	
Pwr: 1EA Duplex NEMA 5-20R	Pwr: 2EA Duplex NEMA 5-20R	Pwr: 2EA Duplex NEMA 5-20R	Pwr: 2EA Duplex NEMA 5-20R	Pwr: 1EA Duplex NEMA 5-20R	

**C2 Transformation Center Ops  
Floor VI BAY - Location TBD**

**FOR OFFICIAL USE ONLY**

**UNITED STATES AIR FORCE**

TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, 1ST FLR, C2 TRANS CNTR VI EQUIPMENT, FACE EQUIPMENT
AUTHOR(S)	AFCAF08B 896 CS/SEHE SCOTT AFB IL 62225 LACKLAND AFB TX DSN (314) 776-5505 DSN (314) 969-2285
FILENAME	OSC-C2TC-VI DATE 13 Jun 2002 PAGE 1 OF 1

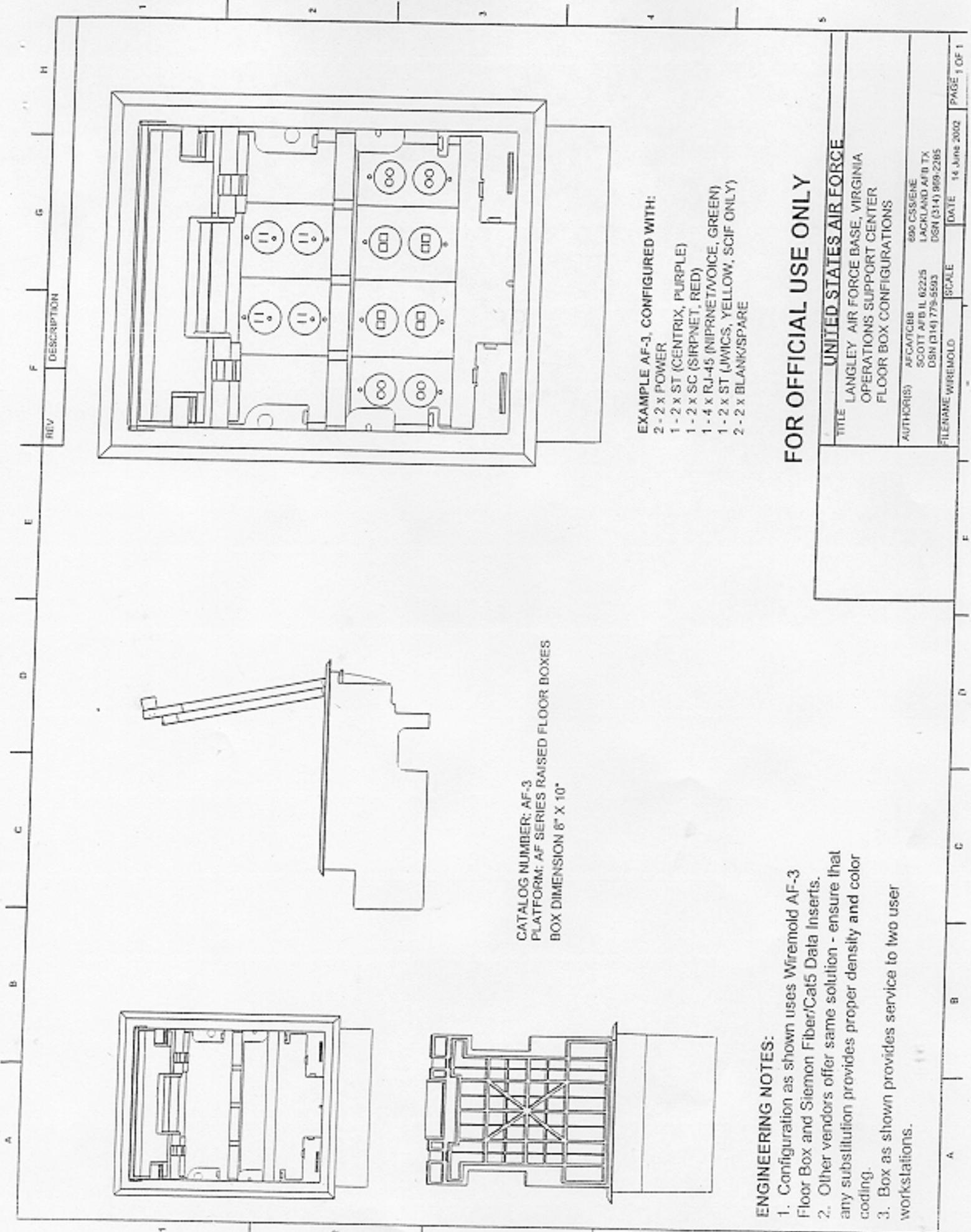
REV	DESCRIPTION	A	B	C	D	E	F	G	H
1									
2									
3									
4									
5									

VI Rack 1401	VI Rack 1402	VI Rack 1403	VI Rack 1404	VI Rack 1405	VI Rack 1406
20' Cable Mgmt FO MM - to data wall SC 12mm CP x 12 30' Cable Mgmt FO MM - to data wall SC 12mm CP x 12 30' Cable Mgmt FO MM - to data wall SC 12mm CP x 12 30' Cable Mgmt FO MM - to data wall SC 12mm CP x 12 30' Cable Mgmt	COVID Receivers	Matrix Switches	Quid Views VCRs	PA	
Part: 1EA Rack NEMA 5-20P	Part: 3EA Rack NEMA 5-20P	Part: 3EA Rack NEMA 5-20P	Part: 3EA Rack NEMA 5-20P	Part: 1EA Rack NEMA 5-20P	Part: 1EA Rack NEMA 5-20P

**C2 Operations Support Center  
Ops Floor VI BAY - Location TBD**

**FOR OFFICIAL USE ONLY**

<b>UNITED STATES AIR FORCE</b>	
TITLE	LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER, 1ST FLR, OSC VI EQUIPMENT, FACE EQUIPMENT
AUTHOR(S)	AWC/TC88 SCOTT AFB IL 62225 LACKLAND AFB TX OSM (314) 779-5569
FILENAME	OSC-OSC-VI
SCALE	3/8" = 1'
DATE	13 JUN 2002
PAGE 1 OF 1	



CATALOG NUMBER: AF-3  
 PLATFORM: AF SERIES RAISED FLOOR BOXES  
 BOX DIMENSION 8" X 10"

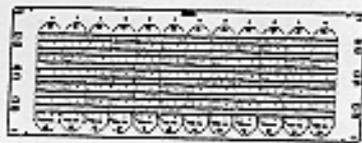
- EXAMPLE AF-3, CONFIGURED WITH:**
- 2 - 2 x POWER
  - 1 - 2 x ST (CENTRIX, PURPLE)
  - 1 - 2 x SC (SIRPNET, RED)
  - 1 - 4 x RJ-45 (NIPRNET/VOICE, GREEN)
  - 1 - 2 x ST (JWICS, YELLOW, SCIF ONLY)
  - 2 - 2 x BLANK/SPARE

**ENGINEERING NOTES:**

1. Configuration as shown uses Wiremold AF-3 Floor Box and Siemon Fiber/Cat5 Data Inserts.
2. Other vendors offer same solution - ensure that any substitution provides proper density and color coding.
3. Box as shown provides service to two user workstations.

**FOR OFFICIAL USE ONLY**

TITLE		UNITED STATES AIR FORCE	
AUTHOR(S)		LANGLEY AIR FORCE BASE, VIRGINIA OPERATIONS SUPPORT CENTER FLOOR BOX CONFIGURATIONS	
FILENAME	WIREMOLD	SCALE	DATE
			14 June 2002
PAGE		1 OF 1	



Slecor CCH-04U

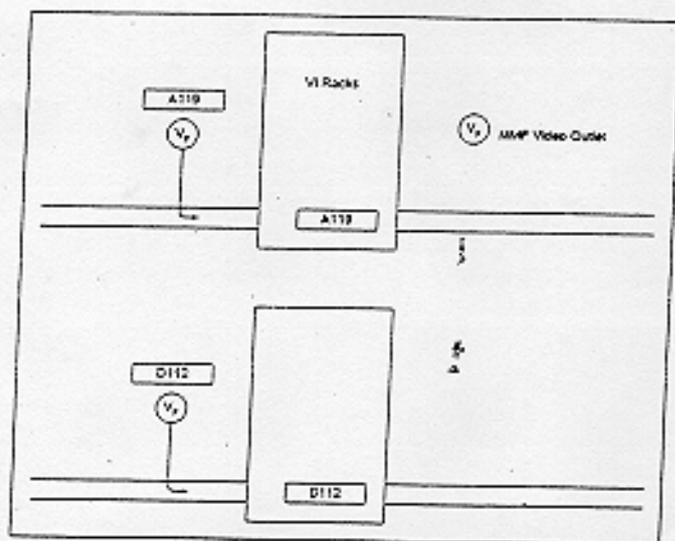


Figure 1. MMF Video Riser Diagram

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
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		02531	SD-02 Shop Drawings															
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		02930a	SD-07 Certificates														
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			SD-06 Test Reports														
			Field Testing of Mortar	3.20.1													
			Field Testing of Grout	3.20.2													
			Prism tests	3.20.3													
			Masonry Cement	2.7.3													
			Fire-rated CMU	2.4.3													
			Special Inspection	1.5.1													
			SD-07 Certificates														
			Clay or Shale Brick	2.2													
			Concrete Brick	2.3													
			Concrete Masonry Units (CMU)	2.4													
			Control Joint Keys	2.12													
			Anchors, Ties, and Bar	2.9													
			Positioners														
			Expansion-Joint Materials	2.14													
			Joint Reinforcement	2.10													
			Reinforcing Steel Bars and Rods	2.11													

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		04200	Masonry Cement	2.7.3													
			Mortar Coloring	2.7.2	G												
			Insulation	2.13													
			Insulation	2.13													
			Precast Concrete Items	2.5	G												
			Admixtures for Masonry Mortar	2.7.1	G												
			Admixtures for Grout	2.8.1	G												
			SD-08 Manufacturer's Instructions														
			Masonry Cement	2.7.3													
		05120	SD-02 Shop Drawings														
			Erection drawings	1.6.1	G AE												
			Fabrication drawings	1.6.1	G AE												
			SD-03 Product Data														
			Shop primer	2.4													
			Load indicator washers	2.2.4													
			SD-06 Test Reports														
			Class B coating	2.4													
			Bolts, nuts, and washers	2.2													
			SD-07 Certificates														
			Steel	2.1													
			Bolts, nuts, and washers	2.2													
			Shop primer	2.4													
			Welding electrodes and rods	2.3.1													
			Nonshrink grout	2.3.2													
			Galvanizing	2.5													
			AISC Quality Certification	1.5													

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		05120	Erection Plan	1.6.2.1													
			Welding procedures and qualifications	1.6.2.2	G AE												
		05210a	SD-02 Shop Drawings														
			Steel Joists	1.3	G AE												
			SD-07 Certificates														
			Steel Joists	1.3													
		05300a	SD-02 Shop Drawings														
			Deck Units	2.1	G AE												
			Accessories	2.5	G AE												
			Attachments	3.2	G AE												
			Holes and Openings	3.3	G AE												
			SD-03 Product Data														
			Deck Units	2.1													
			Attachments	3.2													
			SD-07 Certificates														
			Deck Units	2.1													
			Attachments	3.2													
		05400a	SD-02 Shop Drawings														
			Framing Components	2.1	G AE												
			SD-07 Certificates														
			Welds	3.2.1													
		05500a	SD-02 Shop Drawings														
			Miscellaneous Metal Items	1.6	G AE												
		06100a	SD-07 Certificates														
			Grading and Marking	2.1.1													

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		06100a	Insulation	2.3													
		06200a	SD-02 Shop Drawings														
			Finish Carpentry														
			SD-03 Product Data														
			Wood Items and Trim	2.1													
		06650	SD-02 Shop Drawings														
			Shop Drawings	1.7													
			Installation	3.2													
			SD-03 Product Data														
			Solid polymer material	2.1	G												
			Qualifications	1.6													
			Fabrications	2.3	G												
			SD-04 Samples														
			Material	2.1	G												
			Counter and Vanity Tops	2.3.4	G												
			SD-06 Test Reports														
			Solid polymer material	2.1													
			SD-07 Certificates														
			Fabrications	2.3													
			Qualifications	1.6													
			SD-10 Operation and Maintenance														
			Data														
			Solid polymer material	2.1													
			Clean-up	3.3													
		07110a	SD-07 Certificates														
			Materials	1.4													

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		07131	SD-03 Product Data														
			Elastomeric waterproofing sheet material	2.1													
			Protection board	2.3													
			Primers, adhesives, and mastics	2.1													
			SD-06 Test Reports														
			Elastomeric waterproofing sheet material	2.1													
		07220a	SD-03 Product Data														
			Application of Insulation	3.6													
			Inspection	3.7													
		07416a	SD-02 Shop Drawings														
			Structural Standing Seam Metal Roof	1.2.1	G AE												
			SD-03 Product Data														
			Design Analysis	1.2	G AE												
			Qualifications														
			SD-04 Samples														
			Roof Panels	2.1	G AE												
			Factory Color Finish	2.5	G AE												
			SD-06 Test Reports														
			Uplift Resistance	1.4	G AE												
			SD-07 Certificates														
			Structural Standing Seam Metal Roof	1.2.1	G AE												
		07420	SD-02 Shop Drawings														

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		07420	Panels	2.1	G AE												
			Metal accessories	2.1.2	G AE												
			SD-03 Product Data														
			Panels	2.1	G AE												
			SD-04 Samples														
			Panels	2.1	G AE												
			Metal accessories	2.1.2	G AE												
			SD-06 Test Reports														
			Certified test reports	1.3													
			SD-07 Certificates														
			Materials	2.2													
		07600a	SD-02 Shop Drawings														
			Materials	2.1	G												
		07810a	SD-03 Product Data														
			Fireproofing Material	3.3													
			SD-04 Samples														
			Spray-Applied Fireproofing	2.1													
			SD-06 Test Reports														
			Fire Resistance Rating	1.7													
			Field Tests	3.5													
			SD-07 Certificates														
			Installer Qualifications	1.5													
			Surface Preparation	3.1													
			Manufacturer's Inspection	3.5.3													
		07840a	SD-02 Shop Drawings														
			Firestopping Materials	2.1													

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		07840a	SD-07 Certificates														
			Firestopping Materials	2.1													
			Installer Qualifications	1.5													
			Inspection	3.3													
		07900a	SD-03 Product Data														
			Backing	2.1													
			Bond-Breaker	2.2													
			Sealant	2.4													
			SD-04 Samples														
			sealant	2.4													
			SD-07 Certificates														
			Sealant	2.4													
		08110	SD-02 Shop Drawings														
			Doors	2.1													
			Doors	2.1													
			Frames	2.1													
			Frames	2.1													
			Frames	2.7													
			Frames	2.7													
			Accessories	2.6													
			Weatherstripping	2.9													
			SD-03 Product Data														
			Doors	2.1													
			Frames	2.1													
			Frames	2.7													
			Accessories	2.6													

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		08110	Weatherstripping	2.9													
			Fire rated doors	2.2													
			SD-04 Samples														
			Doors	2.1													
			Frames	2.1													
			Frames	2.7													
			coating	2.11.1													
		08120	SD-02 Shop Drawings														
			Doors and frames	2.1	G AE												
			SD-04 Samples														
			Finishes	2.3.8	G												
			SD-05 Design Data														
			Calculations	1.8	G AE												
			SD-06 Test Reports														
			Aluminum doors	2.3.2													
			windows	1.3.3													
			transoms	2.1													
			sidelights	2.1													
			SD-08 Manufacturer's Instructions														
			Doors and frames	2.1													
		08210	SD-02 Shop Drawings														
			Doors	2.1													
			SD-03 Product Data														
			Doors	2.1													
			Accessories	2.2													
			Water-resistant sealer	2.3.6													

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		08210	warranty	1.4													
			Sound transmission class rating	2.1.2	G												
			Fire resistance rating	2.1.3	G												
			SD-04 Samples														
			Doors	2.1													
			Door finish colors	2.3.5.2													
			SD-06 Test Reports														
			Split resistance	2.4													
			Cycle-slam	2.4													
			Hinge loading resistance	2.4													
		08330a	SD-02 Shop Drawings														
			Overhead Rolling Door Unit	1.6	G												
			SD-03 Product Data														
			Overhead Rolling Door Unit	1.6	G												
			SD-06 Test Reports														
			Tests	1.2.1													
			SD-10 Operation and Maintenance Data														
			Operation	1.6													
			Maintenance	1.6													
		08353	SD-02 Shop Drawings														
			Accordion Partitions	2.2	G												
			SD-03 Product Data														
			Accordion Partitions	2.2	G												
			SD-04 Samples														
			Accordion Partitions	2.2	G												

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		08353	SD-07 Certificates														
			Accordion Partitions	2.2													
			SD-10 Operation and Maintenance Data														
			Accordion Partitions	2.2													
		08710	SD-02 Shop Drawings														
			Hardware schedule	1.3	G												
			Keying system	2.3.7													
			SD-03 Product Data														
			Hardware items	2.3	G												
			SD-08 Manufacturer's Instructions														
			Installation	3.1													
			SD-10 Operation and Maintenance Data														
			Hardware Schedule	1.3	G												
			SD-11 Closeout Submittals														
			Key bitting	1.4													
		08810a	SD-02 Shop Drawings														
			Installation	3.2	G AE												
			SD-03 Product Data														
			Wire glassed		G AE												
			Insulating Glass	2.2	G AE												
			Glazing Accessories	2.7	G AE												
			Laminated glass;	1.6.2	G AE												
			SD-04 Samples														
			Insulating Glass	2.2													

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		08810a	SD-07 Certificates															
			Insulating Glass	2.2														
		09100N	SD-02 Shop Drawings															
			Metal support systems	2.1	G AE													
		09215a	SD-02 Shop Drawings															
			Approved Detail Drawings	1.3														
			SD-03 Product Data															
			Materials	2.1														
			SD-07 Certificates															
			Fire Resistive Construction	1.7														
			Steel Framing, Furring and Related Items	2.1.1														
		09250	SD-03 Product Data															
			Type C	2.1.1.2														
			gypsum board	2.1.1														
			Glass Mat Water-Resistant Gypsum Tile Backing Board	2.1.2														
			Accessories	2.1.8														
		09310A	SD-03 Product Data															
			Tile	2.1	G													
			Mortar and Grout	2.3	G													
			SD-04 Samples															
			Tile	2.1	G													
			Marble Thresholds	2.4	G													
			SD-07 Certificates															
			Tile	2.1														

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		09310A	Mortar and Grout	2.3													
		09390	SD-03 Product Data														
			Synthetic Finish System	3.3	G AE												
			Application	3.1.2													
			SD-04 Samples														
			Synthetic Finish System	3.3	G												
		09490	SD-03 Product Data														
			Special Coating	2.1	G AE												
			Thinning	3.3	G AE												
			Application	3.4	G AE												
			SD-04 Samples														
			Special Coating	2.1	G AE												
		09510A	SD-02 Shop Drawings														
			Approved Detail Drawings	1.3	G AE												
			SD-04 Samples														
			Acoustical Units	2.1	G												
			SD-07 Certificates														
			Acoustical Units	2.1													
		09650A	SD-03 Product Data														
			Flooring	3.2													
			SD-04 Samples														
			Flooring	3.2	G												
			SD-06 Test Reports														
			Moisture Test	3.3													
		09685N	SD-02 Shop Drawings														
			Carpet tile installation	3.1													

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		09685N	SD-04 Samples														
			Carpet tile	2.1	G												
			Carpet tile	2.1	G												
			Molding	2.3	G												
			SD-06 Test Reports														
			Flammability	2.2.8													
			Static control	2.2.9													
			CRI Green Label Requirements for Indoor Air Quality Test Criteria	1.7.1													
			ADA requirements	1.7.2													
			SD-07 Certificates														
			Installation experience	1.4.2													
			Carpet tile	2.1													
			Carpet tile	2.1													
			SD-08 Manufacturer's Instructions														
			Carpet tile installation	3.1													
			SD-10 Operation and Maintenance Data														
			Carpet tile	2.1													
			Carpet tile	2.1													
		09720A	SD-03 Product Data														
			Wallcoverings	2.1													
			Manufacturer's Instructions	3.2													
			Installation	3.3													
			Maintenance	1.6													
			Clean-Up	3.4													

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		09720A	SD-04 Samples														
			Wallcoverings	2.1	G												
			SD-07 Certificates														
			Wallcoverings	2.1													
		09900	SD-02 Shop Drawings														
			Piping identification	3.10													
			stencil	3.10													
			SD-03 Product Data														
			Coating	2.1													
			Manufacturer's Technical Data	2.1													
			Sheets														
			SD-04 Samples														
			Color	1.9	G												
			SD-07 Certificates														
			Applicator's qualifications	1.3													
			Qualification Testing	1.4.1.2													
			SD-08 Manufacturer's Instructions														
			Mixing	3.6.2													
			Manufacturer's Material Safety	1.7.2													
			Data Sheets														
			SD-10 Operation and Maintenance														
			Data														
			Coatings	2.1													
		09915	SD-04 Samples														
			Color Schedule	2.2	G												
		10100A	SD-03 Product Data														

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TITLE AND LOCATION OPERATIONS SUPPORT CENTER, LANGLEY AIR FORCE BASE, VA						CONTRACTOR											
ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH	GOVT CLASSIFICATION	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/	DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		10100A	Visual Display Boards	1.4	G												
			SD-04 Samples														
			Aluminum	2.2.3	G												
			Porcelain Enamel	2.2.1	G												
			Materials	2.2	G												
			SD-07 Certificates														
			Visual Display Boards	1.4													
		10160A	SD-02 Shop Drawings														
			Toilet Partition System	2.1													
			SD-03 Product Data														
			Toilet Partition System	2.1													
			SD-04 Samples														
			Toilet Partition System	2.1	G												
		10201N	SD-02 Shop Drawings														
			Wall louvers	2.2	G												
			SD-04 Samples														
			Wall louvers	2.2	G												
		10270A	SD-02 Shop Drawings														
			Raised Access Floor System	2.4	G												
			SD-03 Product Data														
			Raised Access Floor System	2.4	G												
			SD-04 Samples														
			Raised Access Floor System	2.4	G												
			SD-06 Test Reports														
			Tests	2.6	G												
			Testing of Electrical Resistance	3.2	G												

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		10270A	SD-07 Certificates														
			Raised Access Floor System	2.4													
		10350	SD-02 Shop Drawings														
			Flagpoles	2.1													
			SD-03 Product Data														
			Flagpoles	2.1													
			SD-04 Samples														
			Flagpoles	2.1	G												
			Accessories	1.4.1	G												
		10430A	SD-02 Shop Drawings														
			Approved Detail Drawings	3.1	G												
			SD-03 Product Data														
			Dimensional building letters	2.1													
			Installation	3.1													
			SD-04 Samples														
			Dimensional building letters	2.1	G												
			SD-10 Operation and Maintenance Data														
			Protection and Cleaning	3.1.2													
		10440A	SD-02 Shop Drawings														
			Modular signage system	2.1	G												
			Modular signage system	2.1.1	G												
			SD-03 Product Data														
			Installation	3.2													
			Modular signage system	2.1													
			Modular signage system	2.1.1													

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		10440A	SD-04 Samples														
			Interior Signage	1.3	G												
			Modular signage system	2.1	G												
			Modular signage system	2.1.1	G												
			SD-10 Operation and Maintenance Data														
			Approved Manufacturer's Instructions	3.2													
			Protection and Cleaning	3.4													
		10800A	SD-03 Product Data														
			Finishes	2.1.2	G												
			Accessory Items	2.2	G												
			SD-04 Samples														
			Finishes	2.1.2	G												
			Accessory Items	2.2	G												
		10990	SD-02 Shop Drawings														
			Miscellaneous Specialty Items	1.2	G												
			SD-04 Samples														
			Miscellaneous Specialty Items	1.2	G												
		11162A	SD-02 Shop Drawings														
			Dock Lift	2.1	G												
			SD-03 Product Data														
			Dock Lift	2.1													
			SD-10 Operation and Maintenance Data														
			Dock Lift	2.1													

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		11600	SD-02 Shop Drawings														
			Solid woods	2.1.1	G												
			Lumber core	2.1.2	G												
			Plywoods	2.1.3	G												
			Particleboards	2.1.4	G												
			Tempered welded fiber	2.1.5	G												
			High pressure plastic laminate	2.1.6	G												
			SD-03 Product Data														
			Solid woods	2.1.1													
			Lumber core	2.1.2													
			Plywoods	2.1.3													
			Particleboards	2.1.4													
			Tempered welded fiber	2.1.5													
			High pressure plastic laminate	2.1.6													
			SD-04 Samples														
			Base cabinets	3.1.2	G												
			SD-10 Operation and Maintenance Data														
			equipment and materials	1.1													
		12490A	SD-02 Shop Drawings														
			Approved Detail Drawings	3.2													
			SD-03 Product Data														
			Window Treatments	3.2													
			Hardware	1.3													
			SD-04 Samples														
			Window Treatments	3.2	G												

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		13100	SD-02 Shop Drawings														
			Drawings		G AO												
			SD-07 Certificates														
			Materials	2.1	G AO												
		13210	SD-02 Shop Drawings														
			Aboveground storage tanks (AST)	2.1													
			G.														
			SD-03 Product Data														
			Aboveground storage tanks (AST)	2.1	G AE.												
			Leak Detection System	2.2.1	G AE.												
			High level alarm system	2.2.2	G AE.												
			Tank Level Gage System	2.2.3	G AE.												
			Alarm Control Panel System	2.4.1	G AE.												
			Remote alarm system	2.4.2	G AE.												
			SD-06 Test Reports														
			Field acceptance test	3.2	G AE.												
			SD-08 Manufacturer's Instructions														
			Installation instructions	3.1.1													
			SD-10 Operation and Maintenance Data														
			Aboveground storage tanks(AST)	2.1	G AE.												
			Alarm control panel system	2.4.1	G AE.												
			Accessories for AST's	2.2	G AE.												
		13280	SD-03 Product Data														
			Respiratory Protection Program	1.12	G												

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		13280	Cleanup and Disposal	3.11	G												
			Materials and Equipment	1.2													
			Qualifications	1.5	G												
			Training Program	1.11													
			Medical Requirements	1.10													
			Encapsulants	2.1	G												
			SD-06 Test Reports														
			Exposure Assessment and Air Monitoring	3.9	G												
			Local Exhaust Ventilation	1.20													
			Licenses, Permits and Notifications	1.14	G												
			SD-07 Certificates														
			Equipment	1.23													
		13281	SD-03 Product Data														
			Materials and Equipment	1.18													
			Expendable Supplies	1.19													
			Qualifications	1.5	G												
			SD-06 Test Reports														
			Licences, Permits, and Notifications	1.11	G												
			Accident Prevention Plan (APP)	1.7	G												
			Sampling and Analysis	1.13	G												
			Clearance Report	3.8	G												
		13722	SD-02 Shop Drawings														
			Sound Masking System		G												

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		13722	AE														
			SD-03 Product Data														
			Spare Parts		G												
			RE														
			SD-06 Test Reports														
			Approved Test Procedures		G												
			AE		G												
			Acceptance Tests	3.4	G												
			SD-07 Certificates														
			AE														
			Materials and Equipment														
			GA														
			Sound Masking System Installer														
			Qualification														
			SD-10 Operation and Maintenance														
			Data														
			Sound Masking System, Data		G												
			Package 3														
			AE														
		13930	SD-02 Shop Drawings														
			Sprinkler System Shop Drawings		G AE												
			As-Built Shop Drawings														
			SD-03 Product Data														
			Fire Protection Related Submittals	3.1													
					AE."												
			Components and Equipment Data		G AE												

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		13930	Hydraulic Calculations	1.7	G AE												
			Spare Parts		AE"												
			Preliminary Tests Procedures		G RE												
			Final Acceptance Test Procedures		G RE												
			On-site Training Schedule		G RE												
			Preliminary Tests	3.10	G RE												
			Final Acceptance Test		G RE												
			Fire Protection Specialist		G												
			Qualifications														
			RE														
			Sprinkler System Installer	1.9	G RE												
			Qualifications														
			SD-06 Test Reports														
			Preliminary Tests Report		G												
			RE														
			Final Acceptance Test Report		G RE												
			SD-07 Certificates														
			Fire Protection Specialist		G RE												
			Inspection														
			SD-10 Operation and Maintenance														
			Data														
			Wet Pipe Sprinkler System		G RE												
		14240A	SD-02 Shop Drawings														
			Elevator System		G												
			SD-03 Product Data														

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		14240A	Training Data		G												
			Elevator System														
			Framed Instructions	3.7													
			Test Procedures		G												
			SD-04 Samples														
			Finishes														
			SD-06 Test Reports														
			Testing	3.6	G												
			SD-07 Certificates														
			Qualification Certificates														
			SD-10 Operation and Maintenance Data														
			Elevator System		G												
		15080	SD-04 Samples														
			Thermal Insulation Materials														
		15190	SD-02 Shop Drawings														
			Gas Piping System	3.2	G AE												
			SD-06 Test Reports														
			Testing														
			Pressure Tests	3.15.1													
			Test With Gas	3.15.3													
		15400	SD-02 Shop Drawings														
			Plumbing System	3.7.1													
			Electrical Schematics														
			SD-03 Product Data														
			Welding	1.5.1													

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		15400	Plumbing Fixture Schedule	3.8	G AE												
			Vibration-Absorbing Features		G AE												
			Plumbing System	3.7.1	G AE												
			SD-06 Test Reports														
			Tests, Flushing and Disinfection	3.7													
			Backflow Prevention Assembly		G AE												
			Tests														
			SD-07 Certificates														
			Materials and Equipment														
			Bolts	2.1.1													
			SD-10 Operation and Maintenance														
			Data														
			Plumbing System	3.7.1													
		15569	SD-03 Product Data														
			Manufacturer's Catalog Data		G AE.												
			Spare Parts Data														
			Water Treatment Plan														
			Boiler Water Treatment	2.12													
			Heating System Tests	3.6													
			Qualification														
			Field Instructions	3.8													
			Tests	3.3													
			SD-06 Test Reports														
			Heating System Tests	3.6													
			Water Treatment Tests														

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		15569	SD-10 Operation and Maintenance Data														
			Heating System														
			Water Treatment System	2.12													
		15601	SD-02 Shop Drawings														
			Water chillers	2.1													
			SD-03 Product Data														
			Water chillers	2.1													
			Electric motors and starters	2.1.1.9													
			SD-06 Test Reports														
			Start-up and initial operational tests	3.5.1													
			SD-10 Operation and Maintenance Data														
			Water Chillers	2.1													
			Electric motors and starters	2.1.1.9													
		15895	SD-02 Shop Drawings														
			Drawings	3.1.1	G												
			AE														
			Installation	3.1	G												
			SD-03 Product Data														
			Components and Equipment	2.1	G												
			AE														
			Test Procedures														
			Welding Procedures														
			System Diagrams		G												

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		15895	AE. Similar Services Welding Joints Testing, Adjusting and Balancing Field Training SD-06 Test Reports Performance Tests SD-10 Operation and Maintenance Data Operating and Maintenance Instructions	3.6 3.8  3.7	G AE.  G AE												
		15951	SD-02 Shop Drawings HVAC Control System SD-03 Product Data Service Organizations Equipment Compliance Booklet Commissioning Procedures Performance Verification Test Procedures Training SD-06 Test Reports Commissioning Report Performance Verification Test SD-10 Operation and Maintenance Data Operation Manual	3.1.1   1.6 3.4 1.6  3.6  3.6.2 3.5.3	G AE.  G AE. G RE. G AE. G RE.												

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		15951	Maintenance and Repair Manual	1.6													
		15990	SD-02 Shop Drawings														
			TAB Schematic Drawings and Report Forms	3.3	G AE.												
			SD-03 Product Data														
			TAB Related HVAC Submittals	3.2													
			TAB Procedures	3.5.1	G AE.												
			Calibration	1.4													
			Systems Readiness Check	3.5.2	G AE.												
			TAB Execution	3.5.1	G AE.												
			TAB Verification	3.5.4	G AE.												
			SD-06 Test Reports														
			Design Review Report	3.1	G AE.												
			Systems Readiness Check	3.5.2	G AE.												
			TAB Report	3.5.3	G AE.												
			TAB Verification Report	3.5.4	G AE.												
			SD-07 Certificates														
			Ductwork Leak Testing	3.4	G AE.												
			TAB Firm	1.5.1	G AE.												
			TAB Specialist	1.5.2	G AE.												
		15995	SD-03 Product Data														
			Commissioning Team	3.1													
			Test Procedures		G AE.												
			Test Schedule		G AE.												
			SD-06 Test Reports														
			Test Reports		G AE.												

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		16070	SD-02 Shop Drawings														
			Lighting Fixtures in Buildings	3.2	G AE.												
			Equipment Requirements	1.4	G AE.												
			SD-03 Product Data														
			Lighting Fixtures in Buildings	3.2	G AE.												
			Equipment Requirements	1.4	G AE.												
			Contractor Designed Bracing	1.3.4	G AE.												
		16261	SD-02 Shop Drawings														
			Schematic diagrams	1.5.1	G												
			Interconnecting diagrams	1.5.2	G AE.												
			Installation drawings	1.5.3	G AE.												
			SD-03 Product Data														
			Variable frequency drives	2.1	G AE.												
			Wires and cables	2.3													
			Equipment schedule	1.5.4													
			SD-06 Test Reports														
			VFD Test G.														
			Performance Verification Tests	3.2.2													
			Endurance Test	3.2.3													
			SD-08 Manufacturer's Instructions														
			Installation instructions	1.5.5													
			SD-09 Manufacturer's Field Reports														
			VFD Factory Test Plan	2.5.1													
			G.														
			Factory test results	1.5.6													

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		16261	SD-10 Operation and Maintenance Data														
			Variable frequency drives	2.1													
		16263	SD-02 Shop Drawings														
			Layout	3.6	G												
			General Installation	3.1	G												
			Acceptance	3.8	G												
			SD-03 Product Data														
			Performance Criteria		G												
			Sound Limitations	2.6	G												
			Harmonic Requiremants		G												
			Engine-Generator Parameter Schedule	1.4.1													
			G.														
			Integral Main Fuel Storage Tank		G												
			Day Tank	2.3.4	G												
			Power Factor	3.5.1.2	G												
			Heat Rejected To		G												
			Engine-Generator Space														
			Cooling System	2.5	G												
			Time-Delay on Alarms	2.17.5	G												
			Generator	2.13	G												
			Manufacturer's Catalog	2.2	G												
			Site Welding	1.5.6													
			Spare Parts														
			Onsite Training	3.7													

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		16263	Battery Charger	2.11.3.2													
			Vibration-Isolation	1.5.11	G												
			Posted Data and Instructions	3.6													
			Instructions	3.5.4.1	G												
			Experience	1.5.15													
			Field Engineer	1.5.16													
			General Installation	3.1	G												
			SD-06 Test Reports														
			Factory Inspection and Tests	2.26													
			Factory Tests	2.26.2													
			Onsite Inspection and Tests	3.5													
			SD-07 Certificates														
			Vibration Isolation	1.5.11													
			Prototype Test	2.26.2													
			Reliability and Durability	1.4.4													
			Emissions	2.10													
			Sound Limitations	2.6													
			Site Visit														
			Flywheel Balance														
			Materials and Equipment	2.1													
			Inspections	3.5.3													
			Cooling System	2.5													
			SD-10 Operation and Maintenance														
			Data														
			Operation and Maintenance	3.7													
			Manuals														

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		16263	Maintenance Procedures	3.7													
			Special Tools	2.12													
			Filters	2.4.2													
		16265	SD-02 Shop Drawings														
			UPS System		G AE.												
			Installation	3.1	G AE.												
			SD-03 Product Data														
			Performance Requirements	1.3.4	G AE.												
			Spare Parts														
			G.														
			Field Training	3.4													
			SD-06 Test Reports														
			Factory Testing	2.13	G AE.												
			Field Supervision, Startup and Testing	3.2	G AE.												
		16370	SD-02 Shop Drawings														
			Electrical Distribution System	3.9.3	G												
			AE.														
			As-Built Drawings		G												
			SD-03 Product Data														
			Nameplates	2.3	G												
			AE.														
			Material and Equipment	2.2	G												
			General Installation Requirements	3.1	G												
			SD-06 Test Reports														
			Factory Tests		G												

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		16370	AE.														
			Field Testing	3.9	G												
			Operating Tests	3.9.6	G												
			SD-07 Certificates														
			Material and Equipment	2.2	G												
			SD-10 Operation and Maintenance Data														
			Electrical Distribution System	3.9.3	G												
		16375	SD-02 Shop Drawings														
			Electrical Distribution System	3.11.3	G												
			AE														
			As-Built Drawings														
			SD-03 Product Data														
			Fault Current Analysis	2.18.4	G												
			AE														
			Protective Device	2.18	G												
			Coordination Study	2.18.5	G												
			Nameplates	2.2	G												
			Material and Equipment	2.1	G												
			General Installation Requirements	3.1	G												
			AE.														
			SD-06 Test Reports														
			Factory Tests	2.16	G												

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		16375	AE														
			Field Testing	3.11	G												
			Operating Tests	3.11.8	G												
			Cable Installation	3.2.1.4	G												
			SD-07 Certificates														
			Material and Equipment	2.1	G												
			Cable Joints	3.3	G												
			Cable Installer Qualifications		G												
			SD-10 Operation and Maintenance Data														
			Electrical Distribution System	3.11.3	G												
		16415	SD-02 Shop Drawings														
			Interior Electrical Equipment		G AE												
			SD-03 Product Data														
			Fault Current and Protective Device Coordination Study		G AE												
			Manufacturer's Catalog		G AE												
			Material, Equipment, and Fixture Lists		G AE												
			Installation Procedures		G AE												
			As-Built Drawings	1.2.6													
			G.														
			Onsite Tests	3.22.2	G												
			SD-06 Test Reports														
			Factory Test Reports		G AE												
			Field Test Plan		G AE												

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		16415	Field Test Reports	3.20	G AE												
			SD-07 Certificates														
			Materials and Equipment	1.4	G AE												
		16442	SD-02 Shop Drawings														
			Switchgear Drawings	1.4.2	G												
			AE														
			Paralleling Control System		G												
			SD-03 Product Data														
			Switchgear	2.2	G												
			AE														
			Paralleling Control System		G												
			Paralleling Control System		G												
			software and Programming														
			SD-06 Test Reports														
			Switchgear design tests	2.6.2	G												
			AE														
			Switchgear production tests	2.6.3	G												
			Acceptance checks and tests	3.5.1	G												
			Paralleling Operational Test		G												
			SD-10 Operation and Maintenance														
			Data														
			Switchgear Operation and	1.5.1	G												
			Maintenance														
			AE														
			SD-11 Closeout Submittals														

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		16442	Assembled Operation and Maintenance Manuals	1.5.2													
			Equipment Test Schedule	2.6.1	G												
			AE														
			Request for Settings		G												
			Paralleling Operational Performance		G												
		16443	SD-02 Shop Drawings														
			Switchboard Drawings	1.4.2	G												
			AE.														
			SD-03 Product Data														
			Switchboard	2.2	G												
			AE.														
			SD-06 Test Reports														
			Switchboard design tests		G												
			AE.														
			Switchboard production tests		G												
			Acceptance checks and tests	3.5.1													
			G.														
			SD-10 Operation and Maintenance Data														
			Switchboard Operation and Maintenance	1.5.1	G												
			AE.														
			SD-11 Closeout Submittals														

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		16443	Assembled Operation and Maintenance Manuals AE. Equipment Test Schedule	1.5.2	G												
		16444	SD-02 Shop Drawings Switchboard Drawings AE. SD-03 Product Data Switchboard AE. SD-06 Test Reports Acceptance checks and tests G. SD-10 Operation and Maintenance Data Switchboard Operation and Maintenance AE. SD-11 Closeout Submittals Assembled Operation and Maintenance Manuals AE. Equipment Test Schedule	1.4.2 2.2 3.5.1	G G G												
		16475	SD-03 Product Data Fault Current Analysis	2.11	G AE.												

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		16475	Protective Device Coordination Study	2.11	G AE.												
			Equipment	2.1	G AE.												
			System Coordinator	1.4.1	G AE.												
			Installation	3.2	G AE.												
			SD-06 Test Reports														
			Field Testing	3.3	G AE.												
			SD-07 Certificates														
			Devices and Equipment	1.6	G AE.												
		16528	SD-02 Shop Drawings														
			Lighting System	1.3.1	G												
			Detail Drawings		G												
			AE.														
			As-Built Drawings	3.12.2													
			G.														
			SD-03 Product Data														
			Equipment and Materials		G												
			AE.														
			Spare Parts														
			G.														
			SD-06 Test Reports														
			Operating Test	3.12.1	G												
			Ground Resistance	3.12.2													
			Measurements														
			G.														

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		16528	SD-10 Operation and Maintenance Data														
			Lighting System G.	1.3.1													
		16770	SD-02 Shop Drawings														
			Radio and Public Address System AE.	1.2	G												
			SD-03 Product Data														
			Spare Parts														
			SD-06 Test Reports														
			Approved Test Procedures AO.	3.3	G												
			Acceptance Tests	3.3	G												
			SD-07 Certificates														
			AE.														
			SD-10 Operation and Maintenance Data														
			Radio and Public Address System, Data Package 3		G												
			AO.														
		16783	SD-02 Shop Drawings														
			wiring diagrams and installation details	1.6.1	G												
			AE.														
			system components	1.4.4	G												
			SD-03 Product Data														

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		16783	Attenuators	2.2.2													
			Amplifiers	2.3.1													
			Cables	2.3.2													
			Terminators	2.3.3													
			Splitters/combiners	2.3.4													
			Line Taps	2.3.5													
			G.														
			Outlets	2.3.6													
			Connectors	2.3.7													
			Tilt compensator	2.3.8													
			Grounding block	2.4.1													
			SD-05 Design Data														
			CATV System Loss Calculations	1.6.2	G AE.												
			SD-06 Test Reports														
			Operational test plan	1.6.3	G												
			.														
			Operational test procedures	1.6.4													
			G.														
			System pretest	3.2.1													
			Acceptance tests	3.2.2													
			SD-08 Manufacturer's Instructions														
			Connector Installation	1.6.5													
			G.														