INVITATION FOR BIDS (IFB) VOLUME 1 of 2

SPACE IQT
ACADEMIC FACILITY

Vandenberg AFB, California

VOLUME 1 - BID DOCUMENTS and DIVISION 01 thru DIVISION 08
VOLUME 2 - DIVISION 09 thru DIVISION 16

IFB NO. DACA05- 98-B-0049
SPECIFICATION NO. 9872
DRAWING FILE NO. 221-25-1170

US ARMY CORPS OF ENGINEERS
Sacramento District/Los Angeles District

DIRECTIVE NO. DI No. 2, BY 99 MCP
PROJECT NO. 983005

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

July 6, 1998

Contracting Division

SUBJECT: Required Central Contractor Registration (CCR)

TO: All PROSPECTIVE OFFERORS AND CONTRACTORS

This solicitation incorporates DFARS Clause 252.204-7004, Required Central Contractor Registration. In accordance with this clause, you must be registered in the Department of Defense (DoD) CCR database in order to be eligible for contract award. If you intend to submit an offer for this procurement and are not already registered, you are urged to do so immediately via the Internet. The DOD CCR World Wide Web home page address is: http://ccr.edi.disa.mil. The Defense Logistics Services Center also has a CCR web site at http://www.ccr.dlsc.dla.mil/ which includes an instructional guide.

A "Data Universal Numbering System" (DUNS) number is a mandatory data element for registering. If you do not have a DUNS number, contact Dun and Bradstreet to obtain one at no charge. An offeror within the United States may call 1-800-333-0505. More information about the DUNS number is available from Dun and Bradstreet's Internet home page at http://www.dnb.com/.

A "Commercial and Government Entity" (CAGE) code is another mandatory data element for being registered in the CCR. However, if registration forms from USA companies are submitted without the CAGE code, one will be assigned.

DoD has established a goal of registering an applicant in the CCR database within 48 hours after receipt of a complete and accurate application via the Internet. However, registration of an applicant through a method other than the Internet may take up to 30 days.

Your prompt attention to this matter is vital. Offerors that are not registered should consider applying for registration immediately upon receipt of this solicitation.

Sincerely,

Ruth Anne Ijames
Chief, Contracting Division

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00600	REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF BIDDERS/OFFERORS
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ATCH NO.	
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NOTE: AS A MINIMUM ANY CONTRACT AWARDED AS A RESULT OF THIS SOLICITATION SHALL CONSIST OF THE FOLLOWING DOCUMENTS:

STANDARD FORM 1442, SECTIONS 00010, 00700, 00800, TECHNICAL SPECIFICATIONS AND DRAWINGS, AND ATTACHMENTS AS DESCRIBED IN CONTRACT DOCUMENT.

SECTION 00600, AS COMPLETED BY AWARDEE, IS INCORPORATED INTO ANY RESULTANT CONTRACT BY REFERENCE.

SECTION 00100 IS INCLUDED FOR SOLICITATION PURPOSES ONLY. THIS SECTION WILL BE REMOVED, MAINTAINED IN THE CONTRACT FILE AND NOT MADE PART OF THE CONTRACT.

AMENDMENTS ARE INCORPORATED INTO THE RESULTANT CONTRACT.

SUBCONTRACTING PLAN (IF REQUIRED) BECOMES AN ATTACHMENT TO AND A MATERIAL PART OF THE CONTRACT.

INFORMATION TO OFFERORS OR BIDDERS COVER SHEET	1. SOLICITATION NUMBER DACA05-98-B-0049 Spec. No. 9872	2. *(X one)*	
		X	a. SEALED BID
			b. NEGOTIATED *(RFP)*
			c. NEGOTIATED *(RFQ)*

INSTRUCTIONS

NOTE THE AFFIRMATIVE ACTION REQUIREMENT OF THE EQUAL OPPORTUNITY CLAUSE WHICH MAY APPLY TO THE CONTRACT RESULTING FROM THIS SOLICITATION.

You are cautioned to note the "Certification of Non-Segregated Facilities" in the solicitation. Failure to agree to the certification will render your reply nonresponsive to the terms of solicitations involving awards of contracts exceeding $25,000 which are not exempt from the provisions of the Equal Opportunity clause.

"Fill-ins" are provided on the face and reverse of Standard Form 1442 or other solicitation documents and Sections of Table of Contents in this solicitation and should be examined for applicability.

See the provision of this solicitation entitled either "Late Bids, Modifications of Bids or Withdrawal of Bids" or "Late Proposals, Modifications of Proposals and Withdrawals of Proposals."

When submitting your reply, the envelope used must be plainly marked with the Solicitation Number, as shown above, and the date and local time set forth for bid opening or receipt of proposals in the solicitation document.

If NO RESPONSE is to be submitted, detach this sheet from the solicitation, complete the information requested on reverse, fold, affix postage, and mail. NO ENVELOPE IS NECESSARY.

Replies must set forth full, accurate, and complete information as required by this solicitation *(including attachments)*. The penalty for making false statements is prescribed in 18 U.S.C. 1001.

3. ISSUING OFFICE *(Complete mailing address, including Zip Code)*

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
ATTN: CONTRACTING DIVISION, PLAN ROOM
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

4. ITEMS TO BE PURCHASED *(Brief description)*

SEE SF-1442, BLOCK 10.

TYPE OF CONTRACT: SEE SECTION 00100, FAR CLAUSE 52.216-1

5. PROCUREMENT INFORMATION *(X and complete as applicable)*

X	a. THIS PROCUREMENT IS UNRESTRICTED				
	b. THIS PROCUREMENT IS A _____% SET-ASIDE FOR ONE OF THE FOLLOWING *(X one)*.				(3) Combined Small Business/Labor Area Concerns
		(1) Small Business [8(a)]		(2) Labor Surplus Area Concerns	(4) Small Disadvantaged Business Concerns

6. ADDITIONAL INFORMATION

COMPLETE DETAILS FOR PROPER SUBMISSION OF BIDS ARE FOUND IN SECTIONS 00100, 00600 AND ATTACHMENTS.
REMINDER: ACKNOWLEDGE ALL AMENDMENTS (FILL IN BACK PAGE OF SF-1442 OR RETURN SIGNED COPY OF SF-30). IF ANY OF THE AMENDMENTS FURNISHED AMENDED PAGES WHICH ARE PART OF THE BID, THE AMENDED PAGES MUST BE USED IN THE BID.
BID WILL INCLUDE:

A. COMPLETED AND SIGNED SF-1442 (SECTION 00010)
B. COMPLETED PRICING SCHEDULE (SECTION 00010)
C. COMPLETED REPRESENTATIONS/CERTIFICATIONS (SECTION 00600)
D. DD FORM 2051, CAGE CODE (SEE SECTION 00100, DFARS 252.204-7001, AND ATTACHMENTS). COMPLETE AND SUBMIT IF YOU DO NOT HAVE A CAGE CODE)
E. ACKNOWLEDGEMENT OF AMENDMENTS, IF ANY AMENDMENTS WERE ISSUED
F. ANY OTHER DOCUMENTS REQUIRED BY THE SOLICITATION (SEE ATTACHMENTS SECTION)

7. POINT OF CONTACT FOR INFORMATION

a. NAME (Last, First, Middle Initial)	b. ADDRESS *(Include Zip Code)*
SEE SECTION 00100	
c. TELEPHONE NUMBER *(Include Area Code and Extension) (NO COLLECT CALLS)* SEE SECTION 00100	SAME AS BLOCK 3 ABOVE

8. REASONS FOR NO RESPONSE *(X all that apply)*			
	a. CANNOT COMPLY WITH SPECIFICATIONS		b. CANNOT MEET DELIVERY REQUIREMENT
	c. UNABLE TO IDENTIFY THE ITEM(S)		d. DO NOT REGULARLY MANUFACTURE OR SELL THE TYPE OF ITEMS INVOLVED
	e. OTHER *(Specify)*		

9. MAILING LIST INFORMATION *(X one)*				
	YES		NO	WE DESIRE TO BE RETAINED ON THE MAILING LIST FOR FUTURE PROCUREMENT OF THE TYPE OF ITEM(S) INVOLVED.

10. RESPONDING FIRM	
a. COMPANY NAME	b. ADDRESS *(Include Zip Code)*

c. ACTION OFFICER			
(1) Typed or Printed Name *(Last, First, Middle Initial)*	(2) Title	(3) Signature	(4) Date Signed *(YYMMDD)*

DD Form 1707 Reverse, MAR 89

FOLD *FOLD*

FOLD *FOLD*

FROM

AFFIX
STAMP
HERE

SOLICITATION NUMBER	
DATE *(YYMMDD)*	LOCAL TIME

TO

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
ATTN: CONTRACTING DIVISION, PLAN ROOM
1325 J STREET
SACRAMENTO, CA 95814-2922

SECTION 00010

SOLICITATION, OFFER AND AWARD (STANDARD FORM 1442) AND PRICING SCHEDULE

SOLICITATION, OFFER, AND AWARD (Construction, Alteration, or Repair)	1. SOLICITATION NO.	2. TYPE OF SOLICITATION	3. DATE ISSUED	PAGE OF PAGES
	DACA05-98-B-0049	[X] SEALED BID (IFB) [ ] NEGOTIATED (RFP)	98 OCT 29	1

IMPORTANT - The "offer" section on the reverse must be fully completed by offeror.

4. CONTRACT NO.	5. REQUISITION/PURCHASE REQUEST NO.	6. PROJECT NO.
		983005

7. ISSUED BY CODE

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

8. ADDRESS OFFER TO

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOS ANGELES
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325
ATTN: CONTRACTING DIVISION

9. FOR INFORMATION CALL:	A. NAME	B. TELEPHONE NO. (Include area code) (NO COLLECT CALLS)
	See SECTION 00100	See SECTION 00100

SOLICITATION

NOTE: In sealed bid solicitations, "offer" and "offeror" mean "bid" and "bidder".

10. THE GOVERNMENT REQUIRES PERFORMANCE OF THE WORK DESCRIBED IN THESE DOCUMENTS (Title, identifying no., date):

SPACE IQT
ACADEMIC FACILITY
VANDENBERG AFB, CALIFORNIA

Specification No. 9872

Description: This project consists of a 3800 SM one-story building for Space IQT Academic Facility with exterior concrete masonry units and concrete roof tiles. Exterior features include parking lot and landscaping. Also included in project is HVAC, plumbing, electrical, steel tube columns, steel beams and open web steel joists.

Estimated Cost Range of Project: $5,000,000.00 to $10,000,000.00

11. The Contractor shall begin performance within 10 calendar days and complete it within SECTION 00800, FAR 52.211-10 calendar days after receiving [ ] award, [X] notice to proceed. This performance period is [X] mandatory, [ ] negotiable (See SECTION 00800, FAR 52.211-10.)

12A. THE CONTRACTOR MUST FURNISH ANY REQUIRED PERFORMANCE AND PAYMENT BONDS? (If "YES," indicate within how many calendar days after award in Item 12B.)	12B. CALENDAR DAYS
[X] YES [ ] NO	Ten (10)

13. ADDITIONAL SOLICITATION REQUIREMENTS:

A. Sealed offers in original and O copies to perform the work required are due at the place specified in Item 8 by 1:00 PM (hour) local time, 98 DEC 01 (date). If this is a sealed bid solicitation, offers will be publicly opened at that time. Sealed envelopes containing offers shall be marked to show the offeror's name and address, the solicitation number, and the date and time offers are due.

B. An offer guarantee [X] is, [ ] is not required.

C. All offers are subject to the (1) work requirements, and (2) other provisions and clauses incorporated in the solicitation in full text or by reference.

D. Offers providing less than 60 calendar days for Government acceptance after the date offers are due will not be considered and will be rejected.

OFFER *(Must be fully completed by offeror)*

14. NAME AND ADDRESS OF OFFEROR *(Include ZIP Code)*

15. TELEPHONE NO. *(Include area code)*
( ) FAX ( )

16. REMITTANCE ADDRESS *(Include only if different than Item 14)*

DUNS:_____ CAGE CODE:_____
CODE FACILITY CODE

17. The offeror agrees to perform the work required at the prices specified below in strict accordance with the terms of this solicitation, if this offer is accepted by the Government in writing within _____ calendar days after the date offers are due. *(Insert any number equal to or greater than the minimum requirement stated in Item 13D. Failure to insert any number means the offeror accepts the minimum in Item 13D.)*

AMOUNTS ▶ See Pricing Schedule

18. The offeror agrees to furnish any required performance and payment bonds.

19. ACKNOWLEDGEMENT OF AMENDMENTS
(The offeror acknowledges receipt of amendments to the solicitation - give number and date of each)

AMENDMENT NO.										
DATE										

20A. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER *(Type or print)*

20B. SIGNATURE

20C. OFFER DATE

AWARD *(To be completed by Government)*

See pg. 3 for 20D

21. ITEMS ACCEPTED:

22. AMOUNT

23. ACCOUNTING AND APPROPRIATION DATA

24. SUBMIT INVOICES TO ADDRESS SHOWN IN ▶ ITEM
(4 copies unless otherwise specified)

25. OTHER THAN FULL AND OPEN COMPETITION PURSUANT TO
☐ 10 U.S.C. 2304(c) ( ) ☐ 41 U.S.C. 253(c) ( )

26. ADMINISTERED BY CODE

27. PAYMENT WILL BE MADE BY

CONTRACTING OFFICER WILL COMPLETE ITEM 28 OR 29 AS APPLICABLE

☐ 28. NEGOTIATED AGREEMENT *(Contractor is required to sign this document and return _____ copies to issuing office.)* Contractor agrees to furnish and deliver all items or perform all work requirements identified on this form and any continuation sheets for the consideration stated in this contract. The rights and obligations of the parties to this contract shall be governed by (a) this contract award, (b) the solicitation, and (c) the clauses, representations, certifications, and specifications incorporated by reference in or attached to this contract.

☐ 29. AWARD *(Contractor is not required to sign this document.)* Your offer on this solicitation is hereby accepted as to the items listed. This award consummates the contract, which consists of (a) the Government solicitation and your offer, and (b) this contract award. No further contractual document is necessary.

30A. NAME AND TITLE OF CONTRACTOR OR PERSON AUTHORIZED TO SIGN *(Type or Print)*

31A. NAME OF CONTRACTING OFFICER *(Type or Print)*

30B. SIGNATURE

30C. DATE

31B. UNITED STATES OF AMERICA
BY

31C. AWARD DATE

BLOCK 20D:

(1) IF THE OFFEROR IS A JOINT VENTURE, EACH PARTICIPANT IN THE JOINT VENTURE MUST COMPLETE THE FOLLOWING:

Company Name	Signature	Title
Company Name	Signature	Title
Company Name	Signature	Title

NOTE: If a corporation is participating as a member of a Joint Venture, the certificate below must also be completed and signed.

CORPORATION AUTHORIZATION TO PARTICIPATE IN JOINT VENTURE CERTIFICATE

I, _____, certify that I am the Secretary of the corporation
(name)
named as a participant in a Joint Venture on this offer; that
_____, who signed said offer on behalf of the corporation, was
(name)
then _____ of said corporation; that the signature thereto is
(title)
genuine; that said contract was duly signed, sealed and attested for and in behalf of said corporation by authority of its governing body; and that the corporation is authorized to participate in the Joint Venture on this offer.

_____
(Name of Corporation)

_____
(Secretary)

(2) IF THE OFFEROR IS A PARTNERSHIP, LIST FULL NAME OF ALL PARTNERS BELOW. SIGNATURES BY ALL PARTNERS HERE SIGNIFY THAT THE INDIVIDUAL WHO SIGNED THE OFFER IN BLOCK 20B HAS THE AUTHORITY TO BIND THE PARTNERSHIP.

Name	Signature
Name	Signature
Name	Signature

(3) IF THE OFFEROR IS A CORPORATION, THE OFFER SHALL BE SIGNED IN THE CORPORATE NAME FOLLOWED BY THE WORD "BY" AND THE SIGNATURE OF THE PERSON AUTHORIZED TO SIGN THE OFFER IN BLOCK 20B. PROVIDE PROOF THAT THE PERSON SIGNING FOR THE CORPORATION HAS THE AUTHORITY TO BIND THE CORPORATION BY COMPLETING THE FOLLOWING CERTIFICATE:

CORPORATION AUTHORIZATION CERTIFICATE

I, _____, certify that I am the Secretary of the
(name)
corporation named as offeror in the within offer; that _____,
(name)
who signed said offer on behalf of the corporation, was then

_____ of said corporation, that the signature
(title)
thereto is genuine; that said contract was duly signed, sealed and attested for in behalf of said corporation by authority of its governing body.

_____
(Name of Corporation)

_____
(Secretary)

(4) IF THE OFFEROR IS AN INDIVIDUAL DOING BUSINESS AS A FIRM, THE OFFER SHALL BE SIGNED BY THAT INDIVIDUAL IN BLOCK 20B FOLLOWED BY THE WORDS "AN INDIVIDUAL DOING BUSINESS AS _____ (INSERT NAME OF FIRM).

(5) WHEN AN AGENT SIGNS THE OFFER, PROVIDE PROOF OF THE AGENT'S AUTHORITY TO BIND THE PRINCIPAL.

PRICING SCHEDULE

CONTRACTOR SHALL FURNISH ALL PLANT, LABOR, MATERIAL, EQUIPMENT, ETC. NECESSARY TO PERFORM ALL WORK IN STRICT ACCORDANCE WITH THE TERMS AND CONDITIONS SET FORTH IN THE CONTRACT TO INCLUDE ALL ATTACHMENTS THERETO.

ITEM NO.	DESCRIPTION	AMOUNT
0001	Space IQT Academic Facility, Complete to the 1.5 Meter Building Line. (Except Option Items)	$_____
0002	Site Work and Utilities Outside the 1.5 Meter Building Line, Complete. (Except Option Items)	$_____
	BASE PRICE	$_____
	OPTION ITEM	
0003	(OPTION #1) A.C. Parking Lot with Landscaping, Complete.	$_____
	TOTAL PRICE (BASE PRICE PLUS OPTION ITEM)	$_____

1. Prices must be submitted on all individual items of this Pricing Schedule. Failure to do so may be cause for rejection of bids.

2. If a modification to a price is submitted which provides for a lump sum adjustment to the total price, the application of the lump sum adjustment to each item in the Pricing Schedule must be stated. If it is not stated, the bidder/offeror agrees that the lump sum adjustment shall be applied on a pro rata basis to every item in the Pricing Schedule.

3. The bidder/offeror shall distribute his indirect costs (overhead, profit, bond, etc.) over all the items in the Pricing Schedule. The Government will review all submitted Pricing Schedules for any unbalancing of the items. Any submitted Pricing Schedule determined to be unbalanced may be considered nonresponsive and cause the bidder to be ineligible for award.

4. EFARS 52.214-5000 APPARENT CLERICAL MISTAKES - ARITHMETIC DISCREPANCIES (DEC 1995)--EFARS

(a) For the purpose of initial evaluation of bids/offers, the following will be utilized in resolving arithmetic discrepancies found on the face of the Pricing Schedule as submitted by bidders/offerors:

(1) Obviously misplaced decimal points will be corrected;

(2) Discrepancy between unit price and extended price, the unit price will govern;

(3) Apparent errors in extension of unit prices will be corrected;

(4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purpose of bid/offer evaluation, the Government will proceed on the assumption that the bidder/offeror intends the bid/offer to be evaluated on basis of the unit prices, the total arrived at by resolution of arithmetic discrepancies as provided above and the bid/offer will be so reflected on the abstract of bids/offers.

(c) These correction procedures shall not be used to resolve any ambiguity concerning which bid is low.

5. The successful bidder/offeror grants the options listed in the Pricing Schedule to the Government. This option may be exercised any time up to 120 days after receipt of Notice to Proceed. Exercise of the option occurs upon mailing of written notice to the Contractor's field office or job superintendent. Exercise will be made by the Contracting Officer. The price for exercise of the option includes all work and effort associated with the scope of that item. For determination of lowest bid, see paragraph titled EVALUATION OF OPTIONS in Section 00100 of this solicitation. No additional time for contract completion will be allowed when an option is exercised. The given contract completion time was formulated to include time necessary to perform all option work.

SECTION 00100

INSTRUCTIONS, CONDITIONS AND NOTICES TO BIDDERS/OFFERORS AND EVALUATION CRITERIA FOR AWARD

SECTION 00100

INSTRUCTIONS, CONDITIONS AND NOTICES TO BIDDERS/OFFERORS
AND EVALUATION CRITERIA FOR AWARD

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34.	SAACONS 52.0214-4503	EVALUATION FOR AWARD (JAN 1991)
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SECTION 00100

INSTRUCTIONS, CONDITIONS AND NOTICES TO BIDDERS/OFFERORS AND EVALUATION CRITERIA FOR AWARD

INSTRUCTIONS, CONDITIONS AND NOTICES TO BIDDERS/OFFERORS :

1. SAACONS 52.0214-4581 INQUIRIES (APR 1992)

Perspective bidders/offerors should submit inquiries related to this solicitation by writing or calling the following (collect calls will not be accepted):

(1) For information related to amendments and information on bid opening dates or dates set for receipt of proposals:

Plan Room Fax (916) 557-7842

(2) For inquiries of a contractual nature (solicitation requirements, interpretation of contractual language) call:

Ms. Tricia Christie, Contract Specialist (916) 557-5228
or fax questions to (916) 557-7854.

For bid results only call (213) 452-3235.

(3) All **technical** questions on the specifications or drawings will be submitted in writing (or faxed) to:

Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
ATTN: Contracting Division
1325 J Street
Sacramento CA 95814-2922
FAX: (916) 557-7854

(4) Please include the solicitation number, project title and location of project with your questions. Written inquiries must be received by this office not later than 14 calendar days prior to bid opening date/date set for receipt of offers.

(5) For prospective bidders with electronic mail capabilities, questions of a contractual or technical nature can be sent to. Please include the full name of your company, as well as telephone and fax numbers, in your correspondence.

(6) Oral explanations or instructions are not binding. Any information given to a bidder/offeror which impacts the bid/offer will be given in the form of a written amendment to the solicitation.

2. SAACONS 52.0214-4582 DIRECTIONS FOR SUBMITTING BIDS/PROPOSALS (APR 1992)

Envelopes containing bids/offers must be sealed, marked and addressed as follows:

MARK ENVELOPES:

Solicitation No. DACA05-98-B-0049
Bid Opening/Offer Closing Date: 98 DEC 01
Bid Opening/Offer Closing Time: 1:00 PM (LOCAL TIME)

ADDRESS ENVELOPES TO:

Department of the Army
U.S. Army Engineer District, Los Angeles
ATTN: CESPL-CT-P
P.O. Box 532711
Los Angeles, California 90053-2325

Handcarried bids shall be deposited in Room 1040, 911 Wilshire Blvd., Los Angeles, California, prior to the time and date set for opening of bids or bids may be delivered to Room 1035 immediately prior to bid opening time.

Telegraph Modifications to Bids should be addressed to:

U.S. Army Engineer District, Los Angeles
911 Wilshire Blvd., Room 1040
Los Angeles, California 90017

3. FAR 52.236-27 SITE VISIT (CONSTRUCTION) (FEB 1995), ALTERNATE I (FEB 1995)

(a) The clauses at 52.236-2, Differing Site Conditions, and 52.236-3, Site Investigations and Conditions Affecting the Work, will be included in any contract awarded as a result of this solicitation. Accordingly, offerors or quoters are urged and expected to inspect the site where the work will be performed.

(b) An organized site visit has been schedule for--
Date & Time: Tuesday, November 19, 1998 at 10:00 a.m.

(c) Participants will meet at--
Location: Vandenberg Resident Office, 1318 New Mexico Ave., Building 9360, Room 201 at Vandenberg AFB, California.

(d) For confirmation and reservation of site visit please call Mr. John Moreno at (805) 734-4670 not later than 4:00 p.m. on November 18, 1998.

4. FAR 52.204-6 DATA UNIVERSAL NUMBERING SYSTEM (DUNS) NUMBER (APR 1998)

(a) The offeror shall enter, in the block with its name and address on the cover page of its offer, the annotation "DUNS" followed by the DUNS number that identifies the offeror's name and address exactly as stated in the offer. The DUNS number is a nine-digit number assigned by Dun and Bradstreet Information Services.

(b) If the offeror does not have a DUNS number, it should contact Dun and Bradstreet directly to obtain one. A DUNS number will be provided immediately by telephone at no charge to the offeror. For information on obtaining a DUNS number, the offeror, if located within the United States, should call Dun and Bradstreet at 1-800-333-0505. The offeror should be prepared to provide the following information:

(1) Company name.
(2) Company address.
(3) Company telephone number.
(4) Line of business.
(5) Chief executive officer/key manager.
(6) Date the company was started.
(7) Number of people employed by the company.
(8) Company affiliation.

(c) Offerors located outside the United States may obtain the location and phone number of the local Dun and Bradstreet Information Services office from the Internet home page at http://www.dnb.com/. If an offeror is unable to locate a local service center, it may send an e-mail to Dun and Bradstreet at globalinfo@mail.dnb.com.

5. DFARS 252.204-7001 COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE REPORTING (DEC 1991)

(a) The Offeror is requested to enter its CAGE code on its offer in the block with its name and address. The CAGE code entered must be for that name and address. Enter CAGE before the number.

(b) If the Offeror does not have a CAGE code, it may ask the Contracting Officer to request one from the Defense Logistics Services Center (DLSC). The Contracting Officer will--

(1) Ask the Contractor to complete section B of a DD Form 2051, Request for Assignment of a Commercial and Government Entity (CAGE) Code;
(2) Complete section A and forward the form to DLSC; and
(3) Notify the Contractor of its assigned CAGE code.
(c) Do not delay submission of the offer pending receipt of a CAGE code.

6. SAACONS 52.0209-4501 CONTRACTOR RESPONSIBILITY, PREAWARD SURVEY (JUL 1995)

In order to determine a contractor's responsibility for purposes of contract award in accordance with FAR Part 9, the contractor is required to provide a statement regarding previous experience and past performance in performing comparable work, information related to the business organization, financial resources, and/or plant to be used in performing the work (see Attachments, Preaward Survey). The Preaward Survey is attached to the solicitation for information purposes only. It will be required from only the low bidder. After the Bid Opening, the Government will request this information from the low bidder if the low bidder has not had a contract with the **Los Angeles District** within the last twelve months and the Government will set a due date for its submission. The Preaward Survey is not required as part of the bid package. In order to be determined to be responsible a prospective contractor must:

a. Have adequate financial resources to perform the contract or the ability to obtain them.

b. Be able to comply with the required or proposed delivery or performance schedule, taking into consideration all existing commercial and governmental business commitments.

c. Have a satisfactory performance record. In making the determination of responsibility, the Government Contracting Officer shall consider relevant past performance information. A prospective contractor shall not be determined responsible or nonresponsible solely on the basis of a lack of relevant performance history except when there are special standards set forth in the solicitation which applies to all bidders that must be met in order to receive the award. These special standards may be necessary when unusual expertise or specialized facilities are necessary in the performance of the contract; therefore, in order to be determined to be responsible for that particular contract, the offeror must be able to meet those special standards. A prospective contractor that is or recently has been seriously deficient in contract performance shall be presumed to be nonresponsible unless the Contracting Officer determines that the circumstances were beyond the contractor's control or that the contractor has taken appropriate corrective action. Other responsibility considerations by the Contracting Officer will include past efforts by the contractor to apply sufficient tenacity and perseverance to perform acceptably, to meet quality requirements of contracts, and the contractor's past compliance with subcontracting plans (if required) under recent contracts.

d. Have a satisfactory record of integrity and business ethics.

e. Have the necessary organization, experience, accounting and operational controls, and technical skills, or the ability to obtain them (including, as appropriate, such elements as production control procedures, property control systems, quality assurance measures, and safety programs applicable to materials to be produced or services to be performed by the prospective contractor and subcontractors).

f. Have the necessary production, construction, and technical equipment and facilities, or the ability to obtain them.

g. Be otherwise qualified and eligible to receive an award under applicable laws and regulations.

If the contractor or subcontractor does not already have sufficient resources demonstrated in the completed Preaward Survey, acceptable evidence of "the ability to obtain" the required, adequate resources (all of the resources discussed in subparagraphs a, e, and f above) normally consists of a commitment or explicit arrangement that will be in existence at the time of contract award to rent, purchase or otherwise acquire the needed facilities, equipment, other resources, or personnel.

7. FAR 52.211-14 NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (SEP 1990)

Any contract awarded as a result of this solicitation will be ( ) DX rated order; (X) DO rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR Part 700), and the Contractor will be required to follow all of the requirements of this regulation.

8. DFARS 252.211-7002 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS, STANDARDS, PLANS, DRAWINGS, DATA ITEM DESCRIPTIONS, AND OTHER PERTINENT DOCUMENTS (DEC 1991)

The specifications, standards, plans, drawings, data item descriptions, and other pertinent documents cited in this solicitation are not available for distribution but may be examined at the following location:

US Army Engineer District, Sacramento
Plan Room
1325 J Street
Sacramento CA 95814-2922

9. DFARS 252.211-7003 BRAND NAME OR EQUAL (DEC 1991)

(a) If items in this solicitation are identified as "brand name or equal," the term is intended to be descriptive not restrictive. The "brand name or equal" description is used to portray the characteristics and level of quality that will satisfy the Government's needs. The salient physical, functional, and other characteristics which "equal" products must meet are specified in the solicitation.

(b) To be considered for award, offers of "equal" products, including products (other than the "brand name" item) of the brand name manufacturer, must--

(1) Meet the salient physical, functional, and other characteristics specified in this solicitation;

(2) Clearly identify the item by--

(i) Brand name, if any; and

(ii) Make or model number;

(3) Include descriptive literature such as cuts, illustrations, drawings, or a clear reference to previously furnished descriptive data or information available to the Contracting Officer; and

(4) Clearly describe any modifications the Offeror plans to make in a product to make it conform to the solicitation requirements. Mark any descriptive material to clearly show the modifications.

(c) The Contracting Officer will evaluate "equal" products on the basis of information furnished by the Offeror or identified in the offer and reasonably available to the Contracting Officer. The Contracting Officer is not responsible for locating or securing any information not identified in the offer and reasonably available.

(d) Unless the Offeror clearly indicates in the offer that the product being offered is an "equal" product, the Contracting Officer will consider the offer as offering a brand name product referenced in the solicitation.

10. SAACONS 52.0211-4805 AVAILABILITY OF SPECIFICATIONS, STANDARDS AND DESCRIPTIONS (OCT 1992)

(a) Specifications, standards and descriptions cited in this solicitation are available as indicated below:

(1) Unclassified Federal, Military and Other Specifications and Standards (Excluding Commercial) and Data Item Descriptions: Single copies of specifications cited in this solicitation may be obtained by submitting a written request to the supply point listed below. The request must contain the title of the specification, its number, date and applicable amendments. A telephone order entry system is available with the use of a touch tone telephone. A Customer Number is required to use this system and may be obtained by written request to the address listed below or by telephone (215) 697-2179. In case of urgency, telegraphic requests are acceptable.

Standardization Document
Order Desk, Building 4, Section D
700 Robbins Avenue
Philadelphia PA 19111-5094

Telex Number: 834295
Western Union Number: 710-670-1685
Telephone Number: (215) 697-3321
FAX Number: (215) 697-2978
Telephone Order Entry System (TOES) Numbers: (215) 697-1187 through and including (215) 697-1197

(b) Commercial Specifications, Standards and Descriptions: These specifications, standards and descriptions are not available from Government sources. They may be obtained from the publishers.

(c) The Department of Defense Index of Data Item Descriptions (TD-3) may be ordered on the DD Form 1425. The Department of Defense Index of Specifications and Standards (DODISS) may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(d) Corps of Engineers Publications: The "CRD" series of Corps of Engineers specifications are available for inspection at this office. Copies can be obtained from the U.S. Army Engineer Waterways Experiment Station, ATTN: Publications Distribution, Information Services Branch, P.O. Box 631, Vicksburg, Mississippi 39180. A copy of the Corps of Engineers manual, EM 385-1-1, entitled "Safety and Health Requirements Manual" will be sent to prospective bidders upon request to the Sacramento District Office.

11. FAR 52.214-1 SOLICITATION DEFINITIONS--SEALED BIDDING (JUL 1987)

"Government" means United States Government.
"Offer" means "bid" in sealed bidding.
"Solicitation" means an invitation for bids in sealed bidding.

12. FAR 52.214-3 AMENDMENTS TO INVITATIONS FOR BIDS (DEC 1989)

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.

(b) Bidders shall acknowledge receipt of any amendment to this solicitation (1) by signing and returning the amendment, (2) by identifying the amendment number and date in the space provided for this purpose on the form for submitting a bid, (3) by letter or telegram, or (4) by facsimile, if facsimile bids are authorized in the solicitation. The Government must receive the acknowledgment by the time and at the place specified for receipt of bids.

13. FAR 52.214-4 FALSE STATEMENTS IN BIDS (APR 1984)

Bidders must provide full, accurate, and complete information as required by this solicitation and its attachments. The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.

14. FAR 52.214-5 SUBMISSION OF BIDS (MAR 1997)

(a) Bids and bid modifications shall be submitted in sealed envelopes or packages (unless submitted by electronic means)--

(1) Addressed to the office specified in the solicitation; and

(2) Showing the time and date specified for receipt, the solicitation number, and the name and address of the bidder.

(b) Bidders using commercial carrier services shall ensure that the bid is addressed and marked on the outermost envelope or wrapper as prescribed in subparagraphs (a)(1) and (2) of this provision when delivered to the office specified in the solicitation.

(c) Telegraphic bids will not be considered unless authorized by the solicitation; however, bids may be modified or withdrawn by written or telegraphic notice.

(d) Facsimile bids, modifications, or withdrawals, will not be considered unless authorized by the solicitation.

(e) Bids submitted by electronic commerce shall be considered only if the electronic commerce method was specifically stipulated or permitted by the solicitation.

15. FAR 52.214-6 EXPLANATION TO PROSPECTIVE BIDDERS (APR 1984)

Any prospective bidder desiring an explanation or interpretation of the solicitation, drawings, specifications, etc., must request it in writing soon enough to allow a reply to reach all prospective bidders before the submission of their bids. Oral explanations or instructions given before the award of a contract will not be binding. Any information given a prospective bidder concerning a solicitation will be furnished promptly to all other prospective bidders as an amendment to the solicitation, if that information is necessary in submitting bids or if the lack of it would be prejudicial to other prospective bidders.

16. FAR 52.214-7 LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF BIDS (MAY 1997)

(a) Any bid received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before award is made and it--

(1) Was sent by registered or certified mail not later than the fifth calendar day before the date specified for receipt of bids (<I>e.g</I>., a bid submitted in response to a solicitation requiring receipt of bids by the 20th of the month must have been mailed by the 15th);

(2) Was sent by mail (or telegram or facsimile, if authorized) or hand-carried (including delivery by a commercial carrier) if it is determined by the Government that the late receipt was due primarily to Government mishandling after receipt at the Government installation;

(3) Was sent by U.S. Postal Service Express Mail Next Day Service-Post Office To Addressee, not later than 5:00 p.m. at the place of mailing two working days prior to the date specified for receipt of bids. The term "working days" excludes weekends and U.S. Federal holidays; or

(4) Was transmitted through an electronic commerce method authorized by the solicitation and was received at the initial point of entry to the Government infrastructure not later than 5:00 p.m. one working day prior to the date specified for receipt of bids.

(b) Any modification or withdrawal of a bid is subject to the same conditions as in paragraph (a) of this provision.

(c) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent either by registered or certified mail is the U.S. or Canadian Postal Service postmark both on the envelope or wrapper and on the original receipt from the U.S. or Canadian Postal Service. Both postmarks must show a legible date or the bid, modification, or withdrawal shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U.S. or Canadian Postal Service on the date of mailing. Therefore, bidders should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(d) The only acceptable evidence to establish the time of receipt at the Government installation is the time/date stamp of that installation on the bid wrapper or other documentary evidence of receipt maintained by the installation.

(e) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent by U.S. Postal Service Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on the envelope or wrapper and on the original receipt from the U.S. Postal Service. "Postmark" has the same meaning as defined in paragraph (c) of this provision, excluding postmarks of the Canadian Postal Service. Therefore, bidders should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(f) Notwithstanding paragraph (a) of this provision, a late modification of an otherwise successful bid that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

(g) Bids may be withdrawn by written notice or telegram (including mailgram) received at any time before the exact time set for receipt of bids. If the solicitation authorizes facsimile bids, bids may be withdrawn via facsimile received at any time before the exact time set for receipt of bids, subject to the conditions specified in the provision entitled "Facsimile Bids." A bid may be withdrawn in per- son by a bidder or its authorized representative if, before the exact time set for receipt of bids, the identity of the per- son requesting withdrawal is established and the person signs a receipt for the bid.

(h) If an emergency or unanticipated event interrupts normal Government processes so as to cause postponement of the scheduled bid opening, and urgent Government requirements preclude amendment of the solicitation or other notice of an extension of the opening date, the time specified for receipt of bids will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

17. FAR 52.214-18 PREPARATION OF BIDS--CONSTRUCTION (APR 1984)

(a) Bids must be (1) submitted on the forms furnished by the Government or on copies of those forms, and (2) manually signed. The person signing a bid must initial each erasure or change appearing on any bid form.

(b) The bid form may require bidders to submit bid prices for one or more items on various bases, including--

(1) Lump sum bidding;

(2) Alternate prices;

(3) Units of construction; or

(4) Any combination of subparagraphs (1) through (3) above.

(c) If the solicitation requires bidding on all items, failure to do so will disqualify the bid. If bidding on all items is not required, bidders should insert the words "no bid" in the space provided for any item on which no price is submitted.

(d) Alternate bids will not be considered unless this solicitation authorizes their submission.

18. FAR 52.214-19 CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION (AUG 1996)

(a) The Government will evaluate bids in response to this solicitation without discussions and will award a contract to the responsible bidder whose bid, conforming to the solicitation, will be most advantageous to the Government, considering only price and the price-related factors specified elsewhere in the solicitation.

(b) The Government may reject any or all bids, and waive informalities or minor irregularities in bids received.

(c) The Government may accept any item or combination of items, unless doing so is precluded by a restrictive limitation in the solicitation or the bid.

(d) The Government may reject a bid as nonresponsive if the prices bid are materially unbalanced between line items or subline items. A bid is materially unbalanced when it is based on prices significantly less than cost for some work and prices which are significantly overstated in relation to cost for other work, and if there is a reasonable doubt that the bid will result in the lowest overall cost to the Government even though it may be the low evaluated bid, or if it is so unbalanced as to be tantamount to allowing an advance payment.

19. FAR 52.214-34 SUBMISSION OF OFFERS IN THE ENGLISH LANGUAGE (APR 1991) (APPLICABLE IF DFARS 252.225-7007 OR 252.225-7036 SECTION 00700 OR FAR 52.225-15 SECTION 00800 ARE APPLICABLE)

Offers submitted in response to this solicitation shall be in the English language. Offers received in other than English shall be rejected.

20. FAR 52.214-35 SUBMISSION OF OFFERS IN U.S. CURRENCY (APR 1991) (APPLICABLE IF DFARS 252.225-7007 OR 252.225-7036 SECTION 00700 OR FAR 52.225-15 SECTION 00800 ARE APPLICABLE)

Offers submitted in response to this solicitation shall be in terms of U.S. dollars. Offers received in other than U.S. dollars shall be rejected.

21. SAACONS 52.0214-4583 TELEGRAPHIC BIDS/OFFERS (APR 1992)

TELEGRAPHIC BIDS/OFFERS ARE NOT ACCEPTABLE.

However, bids/offers may be modified or withdrawn by written or telegraphic notice. Any telegram to modify or withdraw a bid/offer sent to this office must be received in the office designated in the Invitation for Bids/Request for Proposal (IFB/RFP) for receipt of bids/offers not later than the exact date and time set for bid opening/receipt of proposals. A telegraphic modification or withdrawal of a bid/offer received in such office by telephone from the receiving telegraph office not later than the exact date and time set for bid opening/receipt of proposals shall be considered. However, the telephone message shall be confirmed by the telegraph company by sending a copy of the written telegram that formed the basis for the telephone call. The written telegram shall be sealed in an envelope by a proper official and sent to the office designated in the IFB/RFP for receipt of bids/offers. The official shall write on the envelope (1) the date and time of receipt and by whom, and (2) the number of the IFB/RFP, and shall sign the envelope. The bidder/offeror is responsible to inform the telegraph company of these requirements. No one from this office will be dispatched to the local telegraph office to pick up any telegram for any reason.

22. SAACONS 52.0214-4584 FACSIMILE BIDS/OFFERS (APR 1992)

Facsimile bids/offers, modifications thereto, or cancellations of bids/offers will not be accepted.

23. FAR 52.216-1 TYPE OF CONTRACT (APR 1984)

The Government contemplates award of a firm, fixed-price contract resulting from this solicitation.

24. SAACONS 52.0219-4581 PREPARATION OF SUBCONTRACTING PLAN (APR 1994)

(a) See FAR 52.219-9, Section 00800, of this solicitation. Located in the Attachments Section of this solicitation is a sample Subcontracting Plan which will aid the Contractor in preparing a Subcontracting Plan in accordance with FAR 52.219-9(d)(1) through (d)(11). Subcontracting Plans will be developed considering only the subcontracts actually to be awarded. Subcontracting Plans are required only from large business firms if the contract price is over $1 million; they are not required from small business firms regardless of the contract price.

(b) The sample Subcontracting Plan is attached to this solicitation for information purposes. A Subcontracting Plan will be required only from the low bidder if the low bidder is a large business and the low bid is over $1 million. The Subcontracting Plan is not required from the low bidder until after the Bid Opening; it is not required as part of the bid package. After the Bid Opening, if the selected bidder fails to submit an acceptable plan within the time prescribed by the Contracting Officer, the bidder will be ineligible for award. Review of the Subcontracting Plan by the Government will be in accordance with FAR 19.705-4.

(c) A Subcontracting Plan which proposes goals less than the recommended goals below must contain support, in writing, for the lesser goals and discuss the Contractor's good faith effort to meet the recommended goals.

(d) In accordance with FAR 19.704 if the contract contains options, the cumulative value of the basic contract and all options is considered in determining whether a Subcontracting Plan is necessary. If a plan is necessary, the Subcontracting Plan shall contain separate parts, one for the basic contract and one for each option. It is necessary to address planned subcontracting dollars and percentages of total to be awarded to small; small, disadvantaged; women-owned small; HBCU/MIs; and qualified nonprofit agencies for the blind and other severely disabled separately for the basic contract period and each option year. All other parts of the Subcontracting Plan only need to be addressed once.

(e) Subcontracts awarded to small, disadvantaged businesses; women-owned small businesses; HBCU/MIs; and qualified nonprofit agencies for the blind and other severely disabled count toward the overall small business goal. HBCU/MIs are counted as a subset of the small, disadvantaged goal. The Corps of Engineers has not been assigned a set goal for HBCU/MIs or qualified nonprofit agencies for the blind and other severely disabled.

(f) Qualified nonprofit agencies for the blind and other severely disabled that have been approved by the Committee for Purchase from People Who Are Blind or Severely Disabled under the Javits-Wagner-O'Day Act (41 U.S.C. 46-48) are eligible as a result of Section 9077 of Pub. L. 102-395 and subsequent Appropriation Acts and Section 808 of Pub. L. 102-484 and 804 of Pub. L. 103-337 through September 30 1997 to participate in the program. Under this authority subcontracts awarded to such entities may be counted toward the prime contractor's small business subcontracting goal through fiscal year 1997.

(g) Contact Mr. Daniel (213)452-3938, Deputy for Small Business, with questions on the Subcontracting Plan requirements and further instructions on submission of Standard Forms 294 and 295 as required by FAR 52.219-9. These forms with clarifying instructions will be furnished by the Deputy for Small Business to the Contractor's Subcontracting Plan Administrator after contract award.

(h) The accepted Subcontracting Plan will be incorporated into and made a material part of the contract.

25. FAR 52.222-23 NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (APR 1984)

(a) The offeror's attention is called to the Equal Opportunity clause and the Affirmative Action Compliance Requirements for Construction clause of this solicitation.

(b) The goals for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation for each trade	Goals for female participation for each trade
19.7%	6.9%

These goals are applicable to all the Contractor's construction work performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, the Contractor shall apply the goals established for the geographical area where the work is actually performed. Goals are published periodically in the Federal Register in notice form, and these notices may be obtained from any Office of Federal Contract Compliance Programs office.

(c) The Contractor's compliance with Executive Order 11246, as amended, and the regulations in 41 CFR 60-4 shall be based on (1) its implementation of the Equal Opportunity clause, (2) specific affirmative action obligations required by the clause entitled "Affirmative Action Compliance Requirements for Construction," and (3) its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade. The Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor, or from project to project, for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, Executive Order 11246, as amended, and the regulations in 41 CFR 60-4. Compliance with the goals will be measured against the total work hours performed.

(d) The Contractor shall provide written notification to the Director, Office of Federal Contract Compliance Programs, within 10 working days following award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the--

(1) Name, address, and telephone number of the subcontractor;
(2) Employer's identification number of the subcontractor;
(3) Estimated dollar amount of the subcontract;
(4) Estimated starting and completion dates of the subcontract; and
(5) Geographical area in which the subcontract is to be performed.

(e) As used in this Notice, and in any contract resulting from this solicitation, the "covered area" is Santa Barbara County, California.

26. SAACONS 52.0228-4504 PERFORMANCE AND PAYMENT BONDS (AUG 1991)

The bidder/offeror whose bid/offer is accepted will, within the time established in the bid, enter into a written contract with the Government and furnish performance and payment bonds on Government Standard Forms in the amounts indicated.

Within ten (10) calendar days after award and prior to Notice to Proceed the contractor shall furnish two bonds, each with good and sufficient surety or sureties acceptable to the Government, namely a performance bond (Standard Form 25) and a payment bond (Standard Form 25-A). The penal sum of such bonds will be as follows:

a. Performance Bond. The penal amount of performance bond shall be one hundred percent (100%) of the original contract price.

b. Payment Bond. The penal amount of payment bond shall equal (i)fifty percent (50%) of the contract price when the contract price is $1,000,000 or less; (ii) forty percent (40%) of the contract price when the contract price is in excess of $1,000,000 but not more than $5,000,000; (iii) $2,500,000 when the contract price is more than $5,000,000.

Any bonds furnished will be furnished by the contractor to the Government prior to Notice to Proceed and commencement of contract performance.

27. SAACONS 52.0228-4506 INDIVIDUAL SURETIES IN SUPPORT OF BID BONDS (AUG 1991)

Bidders/offerors utilizing individual sureties in support of a bid bond shall include a Standard Form (SF) 28 (Affidavit of Individual Surety), accompanied by a pledge of acceptable assets from each person acting as an individual surety, and include these with the SF 24 (Bid Bond), and the bid itself (see clause titled "Pledges of Assets," FAR 52.228-11).

Pledges of acceptable assets shall be in the form of (1) evidence of an escrow account and/or (2) a recorded lien on real estate. If this is an IFB, failure to provide pledges of acceptable assets, with the bid, in the specified form, accompanied by a properly executed SF 24 and SF 28, will render the bidder nonresponsible and thus ineligible for award. If this is an RFP, failure to provide required documentation described herein may cause the offeror to be deemed "unacceptable".

28. SAACONS 52.228-4507 BID GUARANTEE FORM AND AMOUNT (JAN 1993)

When bids/proposals exceed $25,000, the offeror shall furnish a separate bid guarantee in accordance with the solicitation provision titled "Bid Guarantee", FAR 52.228-1. In accordance with FAR 28.101-2 the bid guarantee amount shall be at least 20 percent of the "bid price" but shall not exceed $3 million. When the penal sum is expressed as a percentage, a maximum dollar limitation may be stated. If there are option line items on the Pricing Schedule (Section 00010), the term "bid price" is hereby defined as the total bid not to include any amount for line items designated as "options". In bids/proposals that contain "additives", the "bid price" is defined as the total of all bid items including additive line items. FAR 28.106-1 states that a Standard Form (SF) 24 shall be used for the bid bond. In accordance with FAR 28.202(a)(1), corporate sureties utilized must appear on the list contained in the Department of Treasury Circular 570 titled "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and Acceptable Reinsuring Companies."

29. DFARS 252.228-7004 BONDS OR OTHER SECURITY (DEC 1991)

(a) Offerors shall furnish a bid guarantee in the amount of 20% of bid/offer with their bids/offers. The offeror receiving notice of award shall furnish--

(1) A performance bond in the penal amount of 100% of contract price; and

(2) Payment in full of any sum due the Government.

(b) The Contractor shall furnish the performance bond to the Contracting Officer within ten (10) days after receipt of the notice of award. The Contracting Officer will not issue the notice to proceed until receipt of an acceptable performance bond and payment of any sum due the Government.

(c) Bonds supported by sureties whose names appear on the list contained in Treasury Department Circular 570 are acceptable. Performance bonds from individual sureties are acceptable if each person acting as a surety provides a SF 28, Affidavit of Individual Surety, and a pledge of assets acceptable to the Contracting Officer.

30. FAR 52.233-2 SERVICE OF PROTEST (AUG 1996)

(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from:

U.S. Army Engineer District, Los Angeles
ATTN: Contracting Division
911 Wilshire Blvd., Room 1040
Los Angeles, California 90017

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

31. SAACONS 52.0236-4507 ACCEPTANCE OF OFFERS (AUG 1991)

A written award or acceptance of an offer, mailed or otherwise furnished to the successful offeror within the time for acceptance specified in the offer, shall result in a binding contract without further action by either party.

32. FAR 52.252-3 ALTERATIONS IN SOLICITATION (APR 1984)

Portions of this solicitation are altered as follows: N/A

33. FAR 52.252-5 AUTHORIZED DEVIATIONS IN PROVISIONS (APR 1984)

(a) The use in this solicitation of any Federal Acquisition Regulation (48 CFR Chapter 1) provision with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the provision.
(b) The use in this solicitation of any (48 CFR Chapter 2) provision with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

EVALUATION CRITERIA FOR AWARD:

34. SAACONS 52.0214-4503 EVALUATION FOR AWARD (JAN 1991)

The Government contemplates award of one contract to the responsive, responsible bidder who submits the low bid for the total of the following items in Pricing Schedule:

All line items listed in Pricing Schedule.

If the solicitation's Pricing Schedule contains options, see evaluation of options clause below for information on the procedure used by the Government to determine "low bid".

35. FAR 52.217-5 EVALUATION OF OPTIONS (JUL 1990)

Except when it is determined in accordance with FAR 17.206(b) not to be in the Government's best interests, the Government will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Government to exercise the option(s)

END OF SECTION

SECTION 00600

REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF BIDDERS/OFFERORS

SECTION 00600

REPRESENTATIONS, CERTIFICATIONS
AND OTHER STATEMENTS OF BIDDERS/OFFERORS

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SECTION 00600

REPRESENTATIONS, CERTIFICATIONS
AND OTHER STATEMENTS OF BIDDERS/OFFERORS

1. SAACONS 52.0201.4801 SUBMITTAL INFORMATION (NOV 1993)

Solicitation Number: _____

Offeror's Name, Address, Telephone Number, and Fax Number:

_____

_____

_____

_____

_____
Name of Person to Contact Telephone Number

_____
Fax Number

Commercial & Government Entity (CAGE) Code, if known
(see Section 00100):

_____

DUNS Number, if known:

_____

2. FAR 52.203-2 CERTIFICATE OF INDEPENDENT PRICE DETERMINATION (APR 1985)

(a) The offeror certifies that--

(1) The prices in this offer have been arrived at independently, without, for the purpose of restricting competition, any consultation, communication, or agreement with any other offeror or competitor relating to (i) those prices, (ii) the intention to submit an offer, or (iii) the methods or factors used to calculate the prices offered;

(2) The prices in this offer have not been and will not be knowingly disclosed by the offeror, directly or indirectly, to any other offeror or competitor before bid opening (in the case of a sealed bid solicitation) or contract award (in the case of a negotiated solicitation) unless otherwise required by law; and

(3) No attempt has been made or will be made by the offeror to induce any other concern to submit or not to submit an offer for the purpose of restricting competition.

(b) Each signature on the offer is considered to be a certification by the signatory that the signatory--

(1) Is the person in the offeror's organization responsible for determining the prices being offered in this bid or proposal, and that the signatory has not participated and will not participate in any action contrary to subparagraphs (a)(1) through (a)(3) above; or

(2)(i) Has been authorized, in writing, to act as agent for the following principals in certifying that those principals have not participated, and will not participate in any action contrary to subparagraphs (a)(1) through (a)(3) above_____
(insert full name of person(s) in the offeror's organization responsible for determining the prices offered in this bid or proposal, and the title of his or her position in the offeror's organization);

(ii) As an authorized agent, does certify that the principals named in subdivision (b)(2)(i) above have not participated, and will not participate, in any action contrary to subparagraphs (a)(1) through (a)(3) above; and

(iii) As an agent, has not personally participated, and will not participate, in any action contrary to subparagraphs (a)(1) through (a)(3) above.

(c) If the offeror deletes or modifies subparagraph (a)(2) above, the offeror must furnish with its offer a signed statement setting forth in detail the circumstances of the disclosure.

3. FAR 52.203-11 CERTIFICATION AND DISCLOSURE REGARDING PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (APR 1991)

(a) The definitions and prohibitions contained in the clause, at FAR 52.203-12, Limitation on Payments to Influence Certain Federal Transactions, included in this solicitation, are hereby incorporated by reference in paragraph (b) of this certification.

(b) The offeror, by signing its offer, hereby certifies to the best of his or her knowledge and belief that on or after December 23, 1989,--

(1) No Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment or modification of any Federal contract, grant, loan, or cooperative agreement;

(2) If any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with this solicitation, the offeror shall complete and submit, with its offer, OMB standard form LLL, Disclosure of Lobbying Activities, to the Contracting Officer; and

(3) He or she will include the language of this certification in all subcontract awards at any tier and require that all recipients of subcontract awards in excess of $100,000 shall certify and disclose accordingly.

(c) Submission of this certification and disclosure is a prerequisite for making or entering into this contract imposed by section 1352, title 31, United States Code. Any person who makes an expenditure prohibited under this provision or who fails to file or amend the disclosure form to be filed or amended by this provision, shall be subject to a civil penalty of not less than $10,000, and not more than $100,000, for each such failure.

4. FAR 52.204-3 TAXPAYER IDENTIFICATION (JUN 1997)

(a) Definitions.

"Common parent," as used in this solicitation provision, means that corporate entity that owns or controls an affiliated group of corporations

that files its Federal income tax returns on a consolidated basis, and of which the offeror is a member.

"Corporate status," as used in this solicitation provision, means a designation as to whether the offeror is a corporate entity, an unincorporated entity (e.g., sole proprietorship or partnership), or a corporation providing medical and health care services.

"Taxpayer Identification Number (TIN)," as used in this solicitation provision, means the number required by the IRS to be used by the offeror in reporting income tax and other returns.

(b) All offerors are required to submit the information required in paragraphs (c) through (e) of this solicitation provision in order to comply with reporting requirements of 26 U.S.C. 6041, 6041A, and 6050M and implementing regulations issued by the Internal Revenue Service (IRS). If the resulting contract is subject to the reporting requirements described in FAR 4.903, the failure or refusal by the offeror to furnish the information may result in a 31 percent reduction of payments otherwise due under the contract.

(c) Taxpayer Identification Number (TIN).

/_/ TIN: _____.

/_/ TIN has been applied for.

/_/ TIN is not required because:

/_/ Offeror is a nonresident alien, foreign corporation, or foreign partnership that does not have income effectively connected with the conduct of a trade or business in the U.S. and does not have an office or place of business or a fiscal paying agent in the U.S.;

/_/ Offeror is an agency or instrumentality of a foreign government;

/_/ Offeror is an agency or instrumentality of a Federal, state, or local government;

/_/ Other. State basis. _____

(d) Corporate Status.

/_/ Corporation providing medical and health care services, or engaged in the billing and collecting of payments for such services;

/_/ Other corporate entity;

/_/ Not a corporate entity;

/_/ Sole proprietorship

/_/ Partnership

/_/ Hospital or extended care facility described in 26 CFR 501(c)(3) that is exempt from taxation under 26 CFR 501(a).

(e) Common Parent.

/_/ Offeror is not owned or controlled by a common parent as defined in paragraph (a) of this clause.

/_/ Name and TIN of common parent:

Name _____

TIN _____

5. FAR 52.204-5 WOMEN-OWNED BUSINESS (OCT 1995)

(a) Representation. The offeror represents that it ( ) is, ( ) is not a women-owned business concern.

(b) Definition. "Women-owned business concern," as used in this provision, means a concern which is at least 51 percent owned by o ne or more women; or in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women; and whose management and daily business operations are controlled by one or more women.

6. FAR 52.209-5 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, PROPOSED DEBARMENT, AND OTHER RESPONSIBILITY MATTERS (MAR 1996)

(a)(1) The Offeror certifies, to the best of its knowledge and belief, that--

(i) The Offeror and/or any of its Principals--

(A) Are / / are not / / presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency;

(B) Have / / have not / /, within a three-year period preceding this offer, been convicted of or had a civil judgment rendered against them for: commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, state, or local) contract or subcontract; violation of Federal or state antitrust statutes relating to the submission of offers; or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property; and

(C) Are / / are not / / presently indicted for, or otherwise criminally or civilly charged by a governmental entity with, commission of any of the offenses enumerated in subdivision (a)(1)(i)(B) of this provision.

(ii) The Offeror has / / has not / /, within a three-year period preceding this offer, had one or more contracts terminated for default by any Federal agency.

(2) "Principals," for the purposes of this certification, means officers; directors; owners; partners; and, persons having primary management or supervisory responsibilities within a business entity (e.g., general manager; plant manager; head of a subsidiary, division, or business segment, and similar positions).

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER SECTION 1001, TITLE 18, UNITED STATES CODE.

(b) The Offeror shall provide immediate written notice to the Contracting Officer if, at any time prior to contract award, the Offeror learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(c) A certification that any of the items in paragraph (a) of this provision exists will not necessarily result in withholding of an award under this solicitation. However, the certification will be considered in connection with a determination of the Offeror's responsibility. Failure of the Offeror to furnish a certification or provide such additional information as requested by the Contracting Officer may render the Offeror nonresponsible.

(d) Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by paragraph (a) of this provision. The knowledge and information of an Offeror is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(e) The certification in paragraph (a) of this provision is a material representation of fact upon which reliance was placed when making award. If it is later determined that the Offeror knowingly rendered an erroneous certification, in addition to other remedies available to the Government, the Contracting Officer may terminate the contract resulting from this solicitation for default.

7. DFARS 252.209-7001 DISCLOSURE OF OWNERSHIP OR CONTROL BY THE GOVERNMENT OF A TERRORIST COUNTRY (SEP 1994)

(a) Definitions.

As used in this provision--

(1) "Government of a terrorist country" includes the states and the government of a terrorist country, as well as any political subdivision, agency, or instrumentality thereof.

(2) "Terrorist country" means a country determined by the Secretary of State, under section 6(j)(1)(A) of the Export Administration Act of 1979 (50 U.S.C. App. 2405(j)(i)(A)), to be a country the government of which has repeatedly provided support for actions of international terrorism. As of the date of this provision, terrorist countries include: Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.

(3) "Significant interest" means--

(i) Ownership of or beneficial interest in 5 percent or more of the firm's or subsidiary's securities. Beneficial interest includes holding 5 percent or more of any class of the firm's securities in "nominee shares," "street names," or some other method of holding securities that does not disclose the beneficial owner;

(ii) Holding a management position in the firm, such as a director or officer;

(iii) Ability to control or influence the election, appointment, or tenure of directors or officers in the firm;

(iv) Ownership of 10 percent or more of the assets of a firm such as equipment, buildings, real estate, or other tangible assets of the firm; or

(v) Holding 50 percent or more of the indebtedness of a firm.

(b) Prohibition on award.

In accordance with 10 U.S.C. 2327, no contract may be awarded to a firm or a subsidiary of a firm if the government of a terrorist country has a significant interest in the firm or subsidiary, unless a waiver is granted by the Secretary of Defense.

(c) Disclosure.

If the government of a terrorist country has a significant interest in the Offeror or a subsidiary of the Offeror, the Offeror shall disclose such interest in an attachment to its offer. If the Offeror is a subsidiary, if shall also disclose any significant interest the government of a terrorist country has in any firm that owns or controls the subsidiary. The disclosure shall include--

(1) Identification of each government holding a significant interest; and

(2) A description of the significant interest held by each Government.

8. FAR 52.214-2 TYPE OF BUSINESS ORGANIZATION--SEALED BIDDING (JUL 1987)

The bidder, by checking the applicable box, represents that--

(a) It operates as /_/ a corporation incorporated under the laws of the State of _____, /_/ an individual, /_/ a partnership, /_/ a nonprofit organization, or /_/ a joint venture; or

(b) If the bidder is a foreign entity, it operates as /_/ an individual, /_/ a partnership, /_/ a nonprofit organization, /_/ a joint venture, or /_/ a corporation, registered for business in _____. (country)

9. FAR 52.214-17 AFFILIATED BIDDERS (APR 1984)

(a) Business concerns are affiliates of each other when, either directly or indirectly, (1) one concern controls or has the power to control the other, or (2) a third party controls or has the power to control both.

(b) Each bidder shall submit with its bid an affidavit stating that it has no affiliates, or containing the following information:

(1) The names and addresses of all affiliates of the bidder.

(2) The names and addresses of all persons and concerns exercising control or ownership of the bidder and any or all of its affiliates, and

whether they exercise such control or ownership as common officers, directors, stockholders holding controlling interest, or otherwise.

10. FAR 52.219-1 SMALL BUSINESS PROGRAM REPRESENTATION (FEB 1998)

(a)(1) The standard industrial classification (SIC) code for this acquisition is 1542 - General Contractors-Nonresidential Buildings, Other Than Industrial Buildings and Warehouses.

(2) The small business size standard is $17,000,000

(3) The small business size standard for a concern which submits an offer in its own name, other than on a construction or service contract, but which proposes to furnish a product which it did not itself manufacture, is 500 employees.

(b) *Representations*. (1) The offeror represents as part of its offer that it / / is, / / is not a small business concern.

(2) (Complete only if offeror represented itself as a small business concern in paragraph (b)(1) of this provision.) The offeror represents as part of its offer that it / / is, / / is not a small disadvantaged business concern.

(3) (Complete only if offeror represented itself as a small business concern in paragraph (b)(1) of this provision.) The offeror represents as part of its offer that it / / is, / / is not a women-owned small business concern.

(c) *Definition*s.

"Joint venture," for purposes of a small disadvantaged business (SDB) set-aside or price evaluation preference (as prescribed at 13 CFR 124.321), is a concern that is owned and controlled by one or more socially and economically disadvantaged individuals entering into a joint venture agreement with one or more business concerns and is considered to be affiliated for size purposes with such other concern(s). The combined annual receipts or employees of the concerns entering into the joint venture must meet the applicable size standard corresponding to the SIC code designated for the contract. The majority of the venture's earnings must accrue directly to the socially and economically disadvantaged individuals in the SDB concern(s) in the joint venture. The percentage of the ownership involvement in a joint venture by disadvantaged individuals must be at least 51 percent.

"Small business concern," as used in this provision, means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria in 13 CFR Part 121 and the size standard in paragraph (a) of this provision.

"Small disadvantaged business concern," as used in this provision, means a small business concern that (1) is at least 51 percent unconditionally owned by one or more individuals who are both socially and economically disadvantaged, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one or more socially and economically disadvantaged individuals, and (2) has its management and daily business controlled by one or more such individuals. This term also means a small business concern that is at least 51 percent unconditionally owned by an economically disadvantaged Indian tribe or Native Hawaiian Organization, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one or more of these entities, which has its management and daily business controlled by members of an economically

disadvantaged Indian tribe or Native Hawaiian Organization, and which meets the requirements of 13 CFR Part 124.

"Woman-owned small business concern," as used in this provision, means a small business concern--

(1) Which is at least 51 percent owned by one or more women or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women; and

(2) Whose management and daily business operations are controlled by one or more women.

(d) *Notice*. (1) If this solicitation is for supplies and has been set aside, in whole or in part, for small business concerns, then the clause in this solicitation providing notice of the set-aside contains restrictions on the source of the end items to be furnished.

(2) Under 15 U.S.C. 645(d), any person who misrepresents a firm's status as a small or small disadvantaged business concern in order to obtain a contract to be awarded under the preference programs established pursuant to section 8(a), 8(d), 9, or 15 of the Small Business Act or any other provision of Federal law that specifically references section 8(d) for a definition of program eligibility, shall--

(i) Be punished by imposition of fine, imprisonment, or both;

(ii) Be subject to administrative remedies, including suspension and debarment; and

(iii) Be ineligible for participation in programs conducted under the authority of the Act.

11. FAR 52.219-2 EQUAL LOW BIDS (OCT 1995)

(a) This provision applies to small business concerns only.

(b) The bidder's status as a labor surplus area (LSA) concern may affect entitlement to award in case of tie bids. If the bidder wishes to be considered for this priority, the bidder must identify, in the following space, the LSA in which the costs to be incurred on account of manufacturing or production (by the bidder of the first-tier subcontractors) amount to more than 50 percent of the contract price.

_____ _____

_____ _____

(c) Failure to identify the labor surplus areas as specified in paragraph (b) of this provision will preclude the bidder from receiving priority consideration. If the bidder is awarded a contract as a result of receiving priority consideration under this provision and would not have otherwise received award, the bidder shall perform the contract or cause the contract to be performed in accordance with the obligations of an LSA concern.

12. FAR 52.219-19 SMALL BUSINESS CONCERN REPRESENTATION FOR THE SMALL BUSINESS COMPETITIVENESS DEMONSTRATION PROGRAM (JAN 1997)

(a) Definition.

"Emerging small business" as used in this solicitation, means a small business concern whose size is no greater than 50 percent of the numerical size standard applicable to the standard industrial classification code assigned to a contracting opportunity.

(b) (Complete only if the Offeror has represented itself under the provision at 52.219-1 as a small business concern under the size standards of this solicitation.)

The Offeror represents and certifies as part of its offer that it /__/ is, /__/ is not an emerging small business.

(c) (Complete only if the Offeror is a small business or an emerging small business, indicating its size range.)

Offeror's number of employees for the past 12 months (check this column if size standard stated in solicitation is expressed in terms of number of employees) or Offeror's average annual gross revenue for the last 3 fiscal years (check this column if size standard stated in solicitation is expressed in terms of annual receipts). (Check one of the following.)

No. of Employees	Avg. Annual Gross Revenues
____50 or fewer	_____$1 million or less
____51-100	_____$1,000,001-$2 million
____101-250	_____$2,000,001-$3.5 million
____251-500	_____$3,500,001-$5 million
____501-750	_____$5,000,001-$10 million
____751-1,000	_____$10,000,001-$17 million
____Over 1,000	_____Over $17 million

13. DFARS 252.219-7000 SMALL DISADVANTAGED BUSINESS CONCERN REPRESENTATION (DOD CONTRACTS (JUN 1997)

(a) Definition.

"Small disadvantaged business concern," as used in this provision, means a small business concern, owned and controlled by individuals who are both socially and economically disadvantaged, as defined by the Small Business Administration at 13 CFR Part 124, the majority of earnings of which directly accrue to such individuals. This term also means a small business concern owned and controlled by an economically disadvantaged Indian tribe or Native Hawaiian organization which meets the requirements of 13 CFR 124.112 or 13 CFR 124.113, respectively. In general, 13 CFR Part 124 describes a small disadvantaged business concern as a small business concern--

(1) Which is at least 51 percent unconditionally owned by one or more socially and economically disadvantaged individuals; or

(2) In the case of any publicly owned business, at least 51 percent of the voting stock is unconditionally owned by one or more socially and economically disadvantaged individuals; and

(3) Whose management and daily business operations are controlled by one or more such individuals.

(b) Representations. Check the category in which your ownership falls--

_____ Subcontinent Asian (Asian-Indian) American (U.S. citizen with origins from India, Pakistan, Bangladesh, Sri Lanka, Bhutan, the Maldives Islands, or Nepal)

_____ Asian-Pacific American (U.S. citizen with origins from Japan, China, the Philippines, Vietnam, Korea, Samoa, Guam, U.S. Trust Territory of the Pacific Islands (Republic of Palau), the Northern Mariana Islands, Laos, Kampuchea (Cambodia), Taiwan, Burma, Thailand, Malaysia, Indonesia, Singapore, Brunei, Republic of the Marshall Islands, the Federated States of Micronesia, Macao, Hong Kong, Fiji, Tonga, Kiribati, Tuvalu, or Nauru)

_____ Black American (U.S. citizen)

_____ Hispanic American (U.S. citizen with origins from South America, Central America, Mexico, Cuba, the Dominican Republic, Puerto Rico, Spain, or Portugal)
_____ Native American (American Indians, Eskimos, Aleuts, or Native Hawaiians, including Indian tribes or Native Hawaiian organizations)
_____ Individual/concern, other than one of the preceding, currently certified for participation in the Minority Small Business and Capital Ownership Development Program under Section 8(a) of the Small Business Act
_____ Other

(c) Complete the following--

(1) The offeror is_____ is not _____a small disadvantaged business concern.

(2) The Small Business Administration (SBA) has_____has not _____made a determination concerning the offeror's status as a small disadvantaged business concern. If the SBA has made a determination, the date of the determination was_____and the offeror--
_____ Was found by SBA to be socially and economically disadvantaged and no circumstances have changed to vary that determination.
_____ Was found by SBA not to be socially and economically disadvantaged but circumstances which caused the determination have changed.

(d) Penalties and Remedies. Anyone who misrepresents the status of a concern as a small disadvantaged business for the purpose of securing a contract or subcontract shall--

(1) Be punished by imposition of a fine, imprisonment, or both;

(2) Be subject to administrative remedies, including suspension and debarment; and

(3) Be ineligible for participation in programs conducted under authority of the Small Business Act.

14. FAR 52.222-21 CERTIFICATION OF NONSEGREGATED FACILITIES (APR 1984)

(a) "Segregated facilities," as used in this provision, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees, that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin because of habit, local custom, or otherwise.

(b) By the submission of this offer, the offeror certifies that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The offeror agrees that a breach of this certification is a violation of the Equal Opportunity clause in the contract.

(c) The offeror further agrees that (except where it has obtained identical certifications from proposed subcontractors for specific time periods) it will--

(1) Obtain identical certifications from proposed subcontractors before the award of subcontracts under which the subcontractor will be subject to the Equal Opportunity clause;

(2) Retain the certifications in the files; and

(3) Forward the following notice to the proposed subcontractors (except if the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES.

A Certification of Nonsegregated Facilities must be submitted before the award of a subcontract under which the subcontractor will be subject to the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

15. FAR 52.222-22 PREVIOUS CONTRACTS AND COMPLIANCE REPORTS (APR 1984)

The offeror represents that--

(a) It /_/ has, /_/ has not, participated in a previous contract or subcontract subject either to the Equal Opportunity clause of this solicitation, the clause originally contained in Section 310 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114;

(b) It /_/ has, /_/ has not, filed all required compliance reports; and

(c) Representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained before subcontract awards.

16. FAR 52.223-1 CLEAN AIR AND WATER CERTIFICATION (APR 1984)

The Offeror certifies that--

(a) Any facility to be used in the performance of this proposed contract is /_/ is not /_/ listed on the Environmental Protection Agency (EPA) List of Violating Facilities;

(b) The Offeror will immediately notify the Contracting Officer, before award, of the receipt of any communication from the Administrator, or a designee, of the EPA, indicating that any facility that the Offeror proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities; and

(c) The Offeror will include a certification substantially the same as this certification, including this paragraph (c), in every nonexempt subcontract.

17. FAR 52.223-3 HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA (JAN 1997)

(a) "Hazardous material," as used in this clause, includes any material defined as hazardous under the latest version of Federal Standard No. 313 (including revisions adopted during the term of the contract).

(b) The Offeror must list any hazardous material, as defined in paragraph (a) of this clause, to be delivered under this contract. The hazardous material shall be properly identified and include any applicable identification number, such as National Stock Number or Special Item Number. This information shall also be included on the Material Safety Data Sheet submitted under this contract.

Material (If none, insert None)	Identification No.

(c) This list must be updated during performance of the contract whenever the Contractor determines that any other material to be delivered under this contract is hazardous.

(d) The apparently successful Offeror agrees to submit, for each item as required prior to award, a Material Safety Data Sheet, meeting the requirements of 29 CFR 1910.1200(g) and the latest version of Federal Standard No. 313, for all hazardous material identified in paragraph (b) of this clause. Data shall be submitted in accordance with Federal Standard No. 313, whether or not the apparently successful Offeror is the actual manufacturer of these items. Failure to submit the Material Safety Data Sheet prior to award may result in the apparently successful Offeror being considered nonresponsible and ineligible for award.

(e) If, after award, there is a change in the composition of the item(s) or a revision to Federal Standard No. 313, which renders incomplete or inaccurate the data submitted under paragraph (d) of this clause or the certification submitted under paragraph (c) of this clause, the Contractor shall promptly notify the Contracting Officer and resubmit the data.

(f) Neither the requirements of this clause nor any act or failure to act by the Government shall relieve the Contractor of any responsibility or liability for the safety of Government, Contractor, or subcontractor personnel or property.

(g) Nothing contained in this clause shall relieve the Contractor from complying with applicable Federal, State, and local laws, codes, ordinances, and regulations (including the obtaining of licenses and permits) in connection with hazardous material.

(h) The Government's rights in data furnished under this contract with respect to hazardous material are as follows:

(1) To use, duplicate and disclose any data to which this clause is applicable. The purposes of this right are to--

(i) Apprise personnel of the hazards to which they may be exposed in using, handling, packaging, transporting, or disposing of hazardous materials;

(ii) Obtain medical treatment for those affected by the material; and

(iii) Have others use, duplicate, and disclose the data for the Government for these purposes.

(2) To use, duplicate, and disclose data furnished under this clause, in accordance with subparagraph (h)(1) of this clause, in precedence over any other clause of this contract providing for rights in data.

(3) The Government is not precluded from using similar or data acquired from other sources.

18. FAR 52.223-5 POLLUTION PREVENTION AND RIGHT-TO-KNOW INFORMATION (APR 1998)

(a) Executive Order 12856 of August 3, 1993, requires Federal facilities to comply with the provisions of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U.S.C. 11001-11050) and the Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13101-13109).

(b) The Contractor shall provide all information needed by the Federal facility to comply with the emergency planning reporting requirements of Section 302 of EPCRA; the emergency notice requirements of Section 304 of EPCRA; the list of Material Safety Data Sheets required by Section 311 of

EPCRA; the emergency and hazardous chemical inventory forms of Section 312 of EPCRA; the toxic chemical release inventory of Section 313 of EPCRA, which includes the reduction and recycling information required by Section 6607 of PPA; and the toxic chemical reduction goals requirements of Section 3-302 of Executive Order 12856.

19. DFARS 252.223-7001 HAZARD WARNING LABELS (DEC 1991)

(a) "Hazardous material," as used in this clause, is defined in the Hazardous Material Identification and Material Safety Data clause of this contract.

(b) The Contractor shall label the item package (unit container) of any hazardous material to be delivered under this contract in accordance with the Hazard Communication Standard (29 CFR 1910.1200 et seq.). The Standard requires that the hazard warning label conform to the requirements of the standard unless the material is otherwise subject to the labeling requirements of one of the following statutes:

(1) Federal Insecticide, Fungicide and Rodenticide Act;
(2) Federal Food, Drug and Cosmetics Act;
(3) Consumer Product Safety Act;
(4) Federal Hazardous Substances Act; or
(5) Federal Alcohol Administration Act.

(c) The Offeror shall list which hazardous material listed in the Hazardous Material Identification and Material Safety Data clause of this contract will be labeled in accordance with one of the Acts in paragraphs (b)(1) through (5) of this clause instead of the Hazard Communication Standard. Any hazardous material not listed will be interpreted to mean that a label is required in accordance with the Hazard Communication Standard.

Material (if none, insert "none.")	Act

(d) The apparently successful Offeror agrees to submit, before award, a copy of the hazard warning label for all hazardous materials not listed in paragraph (c) of this clause. The Offeror shall submit the label with the Material Safety Data Sheet being furnished under the Hazardous Material Identification and Material Safety Data clause of this contract.

(e) The Contractor shall also comply with MIL-STD-129, Marking for Shipment and Storage (including revisions adopted during the term of this contract).

20. DFARS 252.225-7006 BUY AMERICAN ACT--TRADE AGREEMENTS--BALANCE OF PAYMENTS PROGRAM CERTIFICATE (JUN 1997) (APPLICABLE IF DFARS 252.225-7007 APPLIES - SEE SECTION 00700)

(a) Definitions.
"Caribbean Basin country end product," "designated country end product," "domestic end product," “NAFTA country end product,” “nondesignated country end product," "qualifying country end product," and "U.S. made end product" have the meanings given in the Trade Agreements and the Buy American Act and Balance of Payments Program clauses of this solicitation.

(b) Evaluation.
Offers will be evaluated in accordance with the policies and procedures of Part 225 of the Defense Federal Acquisition Regulation Supplement. Offers of

foreign end products that are not U.S. made, qualifying country, designated country, Caribbean Basin country, or NAFTA country end products will not be considered for award, unless the Contracting Officer determines that there are no offers of such end products; or the offers of such end products are insufficient to fulfill the requirements; or a national interest exception to the Trade Agreements Act is granted.

(c) Certifications.

(1) The Offeror certifies that--

(i) Each end product, except the end products listed in paragraph (c)(2) of this provision, is a domestic end product (as defined in the Buy American Act and Balance of Payments Program clause of this solicitation); and

(ii) Components of unknown origin are considered to have been mined, produced, or manufactured outside the United States or a qualifying country.

(2) The Offeror must identify and certify all end products that are not domestic end products.

(i) The Offeror certifies that the following supplies qualify as "U.S. made end products" but do not meet the definition of "domestic end product":

_____
(Insert line item number)

(ii) The Offeror certifies that the following supplies are qualifying country end products:

_____
(Insert line item number)

_____
(Insert country of origin)

(iii) The Offeror certifies that the following supplies qualify as designated country end products:

_____
(Insert line item number)

_____
(Insert country of origin)

(iv) The Offeror certifies that the following supplies qualify as Caribbean Basin country end products:

_____
(Insert line item number)

_____
(Insert country of origin)

(v) The Offeror certifies that the following supplies qualify as NAFTA country end products:

_____
(Insert line item number)

_____
(Insert country of origin)

(vi) The Offeror certifies that the following supplies are other nondesignated country end products:

_____
(Insert line item number)

_____
(Insert country of origin)

21. DFARS 252.225-7035 BUY AMERICAN ACT--NORTH AMERICAN FREE TRADE AGREEMENT IMPLEMENTATION ACT--BALANCE OF PAYMENTS PROGRAM CERTIFICATE (MAY 1995) (APPLICABLE IF DFARS 252.225-7036 APPLIES - SEE SECTION 00700)

(a) Definitions.

"Domestic end product," "qualifying country end product," and "U.S. made end product" have the meanings given in the North American Free Trade Agreement Implementation Act or Buy American Act and Balance of Payments Program clauses of this solicitation.

(b) Evaluation.

Offers will be evaluated by giving preference to U.S. made end products, qualifying country end products, or NAFTA country end products over other end products.

(c) Certifications.

(1) The Offeror certifies that--

(i) Each end product, except the end products listed in paragraph (c)(2) of this provision, is a domestic end product (as defined in the Buy American Act and Balance of Payments Program clause of this solicitation); and

(ii) Components of unknown origin are considered to have been mined, produced, or manufactured outside the United States or a qualifying country.

(2) The Offeror must identify and certify all end products that are not domestic end products.

(i) The Offeror certifies that the following supplies qualify as "U.S. made end products" but do not meet the definition of "domestic end product":

_____
(Insert line item number)

(ii) The Offeror certifies that the following supplies are qualifying country (except Canada) end products:

_____ _____
(Insert line item number) (Insert country of origin)

(iii) The Offeror certifies that the following supplies qualify as NAFTA country end products:

_____ _____
(Insert Line item number) (Insert country of origin)

(iv) The Offeror certifies that the following supplies are other non-NAFTA country end products:

_____ _____
(Insert Line item number) (Insert country of origin)

22. DFARS 252.247-7022 REPRESENTATION OF EXTENT OF TRANSPORTATION BY SEA (AUG 1992)

(a) The Offeror shall indicate by checking the appropriate blank in paragraph (b) of this provision whether transportation of supplies by sea is anticipated under the resultant contract. The term supplies is defined in the Transportation of Supplies by Sea clause of this solicitation.

(b) Representation.

The Offeror represents that it--

_____ Does anticipate that supplies will be transported by sea in the performance of any contract or subcontract resulting from this solicitation.

_____ Does not anticipate that supplies will be transported by sea in the performance of any contract or subcontract resulting from this solicitation.

(c) Any contract resulting from this solicitation will include the Transportation of Supplies by Sea clause. If the Offeror represents that it will not use ocean transportation, the resulting contract will also include the Defense FAR Supplement clause at 252.247-7024, Notification of Transportation of Supplies by Sea.

END OF SECTION

SECTION 00700

CONSTRUCTION CONTRACT CLAUSES

SECTION 00700

CONTRACT CLAUSES

FAR 52.252-2 CLAUSES INCORPORATED BY REFERENCE (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

http://www.arnet.gov/References/References.html

CONTRACT CLAUSES BY REFERENCE:

1.	DFARS 252.201-7000	CONTRACTING OFFICER'S REPRESENTATIVE (DEC 1991)
2.	FAR 52.202-1 I	DEFINITIONS (OCT 1995)--ALTERNATE I (APR 1984)
3.	FAR 52.203-3	GRATUITIES (APR 1984)
4.	FAR 52.203-5	COVENANT AGAINST CONTINGENT FEES (APR 1984)
5.	FAR 52.203-6	RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT (JUL 1995)
6.	FAR 52.203-7	ANTI-KICKBACK PROCEDURES (JUL 1995)
7.	FAR 52.203-10	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY (JAN 1997)
8.	FAR 52.203-12	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (JUN 1997) (APPLICABLE OVER $100,000)
9.	DFARS 252.203-7001	SPECIAL PROHIBITION ON EMPLOYMENT (JUN 1997)
10.	DFARS 252.203-7002	DISPLAY OF DOD HOTLINE POSTER (DEC 1991) (APPLICABLE OVER $5 MILLION)
11.	FAR 52.204-2 II	SECURITY REQUIREMENTS (AUG 1996)--ALTERNATE II (APR 1984) (APPLICABLE IF CONTRACTOR HAS ACCESS TO CLASSIFIED INFORMATION)
12.	DFARS 252.204-7000	DISCLOSURE OF INFORMATION (DEC 1991) (APPLICABLE IF CONTRACTOR HAS ACCESS TO INFORMATION INAPPROPRIATE FOR RELEASE)
13.	DFARS 252.205-7000	PROVISION OF INFORMATION TO COOPERATIVE AGREEMENT HOLDERS (DEC 1991) (APPLICABLE OVER $500,000)
14.	FAR 52.209-6	PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRACTORS DEBARRED, SUSPENDED OR PROPOSED FOR DEBARMENT (JUL 1995)

15.	DFARS 252.209-7000	ACQUISITION FROM SUBCONTRACTORS SUBJECT TO ON-SITE INSPECTION UNDER THE INTERMEDIATE-RANGE NUCLEAR FORCES (INF) TREATY (NOV 1995)
16.	FAR 52.211-15	DEFENSE PRIORITY AND ALLOCATION REQUIREMENTS (SEP 1990)
17.	FAR 52.211-18	VARIATION IN ESTIMATED QUANTITY (APR 1984) (APPLICABLE IF THERE ARE ESTIMATED-QUANTITY LINE ITEMS IN PRICING SCHEDULE)
18.	FAR 52.214-26	AUDIT AND RECORDS--SEALED BIDDING (OCT 1997) (APPLICABLE IF SEALED BIDDING - SEE BLOCK 2, SF1442 - AND OVER $500,000)
19.	FAR 52.214-27	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA-MODIFICATIONS-SEALED BIDDING (OCT 1997) (APPLICABLE IF SEALED BIDDING - SEE BLOCK 2, SF1442 - AND OVER $500,000)
20.	FAR 52.214-28	SUBCONTRACTOR COST OR PRICING DATA--MODIFICATIONS--SEALED BIDDING (OCT 1997) (APPLICABLE IF SEALED BIDDING - SEE BLOCK 2, SF1442 - AND OVER $500,000)
21.	FAR 52.214-29	ORDER OR PRECEDENCE--SEALED BIDDING (JAN 1986) (APPLICABLE IF SEALED BIDDING - SEE BLOCK 2, SF1442)
22.	FAR 52.215-2	AUDIT AND RECORDS--NEGOTIATION (AUG 1996) (APPLICABLE IF CONTRACTING BY NEGOTIATIONS)
23.	FAR 52.215-10	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA (OCT 1997) (APPLICABLE IF CONTRACTING BY NEGOTIATIONS AND COST OR PRICING DATA IS REQUIRED)
24.	FAR 52.215-11	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA -- MODIFICATIONS (OCT 1997) (APPLICABLE IF CONTRACTING BY NEGOTIATIONS AND COST OR PRICING DATA IS REQUIRED FOR PRICING OF MODIFICATIONS)
25.	FAR 52.215-12	SUBCONTRACTOR COST OR PRICING DATA (OCT 1997) (APPLICABLE FAR 52.215-10 APPLIES)
26.	FAR 52.215-13	SUBCONTRACTOR COST OR PRICING DATA - MODIFICATIONS (OCT 1997) (APPLICABLE FAR 52.215-11 APPLIES)
27.	FAR 52.215-15	TERMINATION OF DEFINED BENEFIT PENSION PLANS (OCT 1997) (APPLICABLE IF COST OR PRICING DATA IS REQUIRED AND FOR WHICH ANY PREAWARD OR POSTAWARD COST DETERMINATIONS WILL BE SUBJECT TO FAR SUBPART 31.2)
28.	FAR 52.215-17	WAIVER OF FACILITIES CAPITAL COST OF MONEY (OCT 1997) (APPLICABLE ANY TIME THE COST PRINCIPLES OF FAR 31.2 APPLY - MODIFICATIONS - AND ORIGINAL

		BID/OFFER DID NOT INCLUDE FACILITIES CAPITAL COST OF MONEY)
29.	FAR 52.215-18	REVERSION OR ADJUSTMENT OF PLANS FOR POSTRETIREMENT BENEFITS (PRB) OTHER THAN PENSIONS (OCT 1997) (APPLICABLE IF COST OR PRICING DATA WILL BE REQUIRED OR FOR WHICH ANY PREAWARD OR POSTAWARD COST DETERMINATIONS WILL BE SUBJECT TO FAR SUBPART 31.2)
30.	DFARS 252.215-7000	PRICING ADJUSTMENTS (DEC 1991) (APPLICABLE IF FAR 52.215-12 APPLIES)
31.	DFARS 252.215-7002	COST ESTIMATING SYSTEM REQUIREMENTS (JUL 1997) (APPLICABLE IF NEGOTIATED - SEE BLOCK 2, SF 1442 - AND CONTRACT AWARD IS MADE ON THE BASIS OF CERTIFIED COST OR PRICING DATA)
32.	FAR 52.219-6	NOTICE OF TOTAL SMALL BUSINESS SET-ASIDE (JUL 1996) (APPLICABLE IF SET ASIDE FOR SMALL BUSINESS - SEE DD FORM 1707)
33.	FAR 52.219-8	UTILIZATION OF SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS CONCERNS (JUN 1997)
34.	FAR 52.219-16	LIQUIDATED DAMAGES--SUBCONTRACTING PLAN (OCT 1995) (APPLICABLE IF FAR 52.219-9 IS APPLICABLE)
35.	DFARS 252.219-7003	SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS SUBCONTRACTING PLAN (DOD CONTRACTS) (APR 1996) (APPLICABLE IF FAR 52.219-9 IS APPLICABLE)
36.	FAR 52.222-3	CONVICT LABOR (AUG 1996)
37.	FAR 52.222-4	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT-OVERTIME COMPENSATION (JUL 1995)
38.	FAR 52.222-6	DAVIS-BACON ACT (FEB 1995)
39.	FAR 52.222-7	WITHHOLDING OF FUNDS (FEB 1988)
40.	FAR 52.222-8	PAYROLLS AND BASIC RECORDS (FEB 1988)
41.	FAR 52.222-9	APPRENTICES AND TRAINEES (FEB 1988)
42.	FAR 52.222-10	COMPLIANCE WITH COPELAND ACT REQUIREMENTS (FEB 1988)
43.	FAR 52.222-11	SUBCONTRACTS (LABOR STANDARDS) (FEB 1988)
44.	FAR 52.222-12	CONTRACT TERMINATION--DEBARMENT (FEB 1988)
45.	FAR 52.222-13	COMPLIANCE WITH DAVIS-BACON AND RELATED ACT REGULATIONS (FEB 1988)
46.	FAR 52.222-14	DISPUTES CONCERNING LABOR STANDARDS (FEB 1988)

47.	FAR 52.222-15	CERTIFICATION OF ELIGIBILITY (FEB 1988)
48.	FAR 52.222-26	EQUAL OPPORTUNITY (APR 1984)
49.	FAR 52.222-27	AFFIRMATIVE ACTION COMPLIANCE REQUIREMENTS FOR CONSTRUCTION (APR 1984)
50.	FAR 52.222-35	AFFIRMATIVE ACTION FOR DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA (APR 1998)
51.	FAR 52.222-36	AFFIRMATIVE ACTION FOR HANDICAPPED WORKERS (APR 1984)
52.	FAR 52.222-37	EMPLOYMENT REPORTS ON DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA (APR 1998)
53.	FAR 52.223-2	CLEAN AIR AND WATER (APR 1984) (APPLICABLE OVER $100,000 AND THE ANSWER TO SECTION 00600, 52.223-1, IS YES)
54.	FAR 52.223-6	DRUG-FREE WORKPLACE (JAN 1997)
55.	DFARS 252.223-7002	SAFETY PRECAUTIONS FOR AMMUNITION AND EXPLOSIVES (MAY 1994) (APPLICABLE IF EXPLOSIVES ARE USED)
56.	DFARS 252.223-7003	CHANGE IN PLACE OF PERFORMANCE--AMMUNITION AND EXPLOSIVES (DEC 1991) (APPLICABLE IF EXPLOSIVES ARE USED)
57.	FAR 52.225-11	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES (OCT 1996)

58.	DFARS 252.225-7007	TRADE AGREEMENTS ACT (JUL 1997) (APPLICABLE IF CONTRACT AMOUNT IS $182,000 OR OVER EXCEPT WHEN SMALL OR SMALL, DISADVANTAGED BUSINESS PREFERENCE PROGRAM APPLIES TO THIS ACQUISITION)
59.	DFARS 252.225-7008	SUPPLIES TO BE ACCORDED DUTY-FREE ENTRY (DEC 1991)
60.	DFARS 252.225-7009	DUTY-FREE ENTRY--QUALIFYING COUNTRY END PRODUCTS AND SUPPLIES (JAN 1997)
61.	DFARS 252.225-7012	PREFERENCE FOR CERTAIN DOMESTIC COMMODITIES (SEP 1997)
62.	DFARS 252.225-7026	REPORTING OF CONTRACT PERFORMANCE OUTSIDE THE UNITED STATES (NOV 1995) (APPLICABLE OVER $500,000)
63.	DFARS 252.225-7036	NORTH AMERICAN FREE TRADE AGREEMENT IMPLEMENTATION ACT (JAN 1994) (APPLICABLE IF CONTRACT AMOUNT IS $6,500,000 OR OVER EXCEPT WHEN SMALL OR SMALL, DISADVANTAGED BUSINESS PREFERENCE PROGRAM APPLIES TO THIS ACQUISITION)
64.	DFARS 252.225-7037	DUTY-FREE ENTRY--NAFTA COUNTRY END PRODUCTS AND SUPPLIES (JAN 1997) (APPLICABLE IF DFARS 252.225-7036 APPLIES - SEE ABOVE)
65.	FAR 52.226-1	UTILIZATION OF INDIAN ORGANIZATIONS AND INDIAN-OWNED ECONOMIC ENTERPRISES (SEP 1996) (APPLICABLE IF FAR 52.219-9 IS APPLICABLE)
66.	FAR 52.227-1	AUTHORIZATION AND CONSENT (JUL 1995)
67.	FAR 52.227-4	PATENT INDEMNITY--CONSTRUCTION CONTRACTS (APR 1984)
68.	FAR 52.227-11	PATENT RIGHTS--RETENTION BY THE CONTRACTOR (SHORT FORM) (JUN 1997) (APPLICABLE IF NONSTANDARD WORK AND SMALL BUSINESS - SEE FAR 27.304-3)
69.	FAR 52.227-12	PATENT RIGHTS--RETENTION BY THE CONTRACTOR (LONG FORM) (JAN 1997) (APPLICABLE IF NONSTANDARD WORK AND LARGE BUSINESS - SEE FAR 27.304-3)
70.	DFARS 252.227-7000	NON-ESTOPPEL (OCT 1966)

71.	DFARS 252.227-7022	GOVERNMENT RIGHTS (UNLIMITED) (MAR 1979) (APPLICABLE TO CONSTRUCTION INVOLVING DESIGN SERVICES)
72.	DFARS 252.227-7023	DRAWINGS AND OTHER DATA TO BECOME PROPERTY OF GOVERNMENT (MAR 1979) (APPLICABLE TO CONSTRUCTION INVOLVING DESIGN SERVICES)
73.	DFARS 252.227-7024	NOTICE AND APPROVAL OF RESTRICTED DESIGNS (APR 1984) (APPLICABLE TO CONSTRUCTION INVOLVING DESIGN SERVICES)
74.	DFARS 252.227-7033	RIGHTS IN SHOP DRAWINGS (APR 1966)
75.	DFARS 252.227-7034	PATENTS--SUBCONTRACTS (APR 1984)
76.	DFARS 252.227-7039	PATENTS--REPORTING OF SUBJECT INVENTIONS (APR 1990) (APPLICABLE IF FAR 52.227-11 ABOVE IS APPLICABLE)
77.	FAR 52.228-1	BID GUARANTEE (SEP 1996)
78.	FAR 52.228-2	ADDITIONAL BOND SECURITY (OCT 1997)
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81.	FAR 52.229-5	TAXES--CONTRACTS PERFORMED IN U.S. POSSESSIONS OR PUERTO RICO (APR 1984)
82.	DFARS 252.231-7000	SUPPLEMENTAL COST PRINCIPLES (DEC 1991)
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88.	FAR 52.236-2	DIFFERING SITE CONDITIONS (APR 1984)
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90.	FAR 52.236-5	MATERIALS AND WORKMANSHIP (APR 1984)
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95.	FAR 52.236-10	OPERATIONS AND STORAGE AREAS (APR 1984)
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98.	FAR 52.236-13 I	ACCIDENT PREVENTION (NOV 1991)--ALTERNATE I (NOV 1991)
99.	FAR 52.236-15	SCHEDULES FOR CONSTRUCTION CONTRACTS (APR 1984) (APPLICABLE IF PERFORMANCE PERIOD EXCEEDS 60 DAYS)
100.	FAR 52.236-17	LAYOUT OF WORK (APR 1984)
101.	FAR 52.236-21 I	SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FEB 1997)--ALTERNATE I (APR 1984)
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103.	DFARS 252.236-7008	CONTRACT PRICES-BIDDING SCHEDULES (DEC 1991) (APPLICABLE IF THERE ARE UNIT PRICES)
104.	FAR 52.242-13	BANKRUPTCY (JUL 1995)
105.	FAR 52.242-14	SUSPENSION OF WORK (APR 1984)
106.	DFARS 252.242-7000	POSTAWARD CONFERENCE (DEC 1991)
107.	FAR 52.243-4	CHANGES (AUG 1987)
108.	DFARS 252.243-7001	PRICING OF CONTRACT MODIFICATIONS (DEC 1991)
109.	FAR 52.244-1	SUBCONTRACTS (FIXED-PRICE CONTRACTS) (OCT 1997) (APPLICABLE OVER $500,000)

110. FAR 52.245-1	PROPERTY RECORDS (APR 1984) (APPLICABLE IF GOVERNMENT-FURNISHED PROPERTY (GFP) IS INVOLVED AND THE GOVERNMENT WILL MAINTAIN OFFICIAL PROPERTY RECORDS-IF THERE IS ANY GFP SECTION 00800 WILL CONTAIN A LIST OF THE GFP)
111. FAR 52.245-2	GOVERNMENT PROPERTY (FIXED-PRICE CONTRACTS (DEC 1989) (APPLICABLE IF GOVERNMENT-FURNISHED PROPERTY IS INVOLVED WORTH OVER $100,000-SEE SECTION 00800)
112. FAR 52.245-4	GOVERNMENT-FURNISHED PROPERTY (SHORT FORM) (APR 1984) (APPLICABLE IF GOVERNMENT-FURNISHED PROPERTY IS INVOLVED WORTH $100,000 OR LESS - SEE SECTION 00800)
113. DFARS 252.245-7001	REPORTS OF GOVERNMENT PROPERTY (MAY 1994) (APPLICABLE IF FAR 52.245-2 IS APPLICABLE)
114. FAR 52.246-21	WARRANTY OF CONSTRUCTION (MAR 1994) (NOT APPLICABLE TO CONTRACTS SOLELY FOR DREDGING, EXCAVATION, GRUBBING OR CLEARING; EFARS 46.710)
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117. FAR 52.249-1	TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (FIXED-PRICE) (SHORT FORM) (APR 1984) (APPLICABLE $100,000 OR LESS)
118. FAR 52.249-2 I	TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (FIXED-PRICE) (SEP 1996)--ALTERNATE I (SEP 1996) (APPLICABLE OVER $100,000)
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END OF SECTION

SECTION 00800

SPECIAL CONTRACT REQUIREMENTS

SECTION 00800

SPECIAL CONTRACT REQUIREMENTS

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10.	DFARS 252.223-7006	PROHIBITION ON STORAGE AND DISPOSAL OF TOXIC AND HAZARDOUS MATERIALS (APR 1993)
11.	SAACONS 52.0223-4803	HAZARDOUS MATERIALS DELIVERED UNDER THIS CONTRACT (MAY 1993)
12.	FAR 52.228-5	INSURANCE--WORK ON A GOVERNMENT INSTALLATION (JAN 1997)
13.	SAACONS 52.0228-4502	MINIMUM INSURANCE REQUIRED (MAY 1993)
14.	EFARS 52.231-5000	EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)--EFARS
15.	FAR 52.232-27	PROMPT PAYMENT FOR CONSTRUCTION CONTRACTS (JUN 1997)
16.	DFARS 252.232-7006	REDUCTION OR SUSPENSION OF CONTRACT PAYMENTS UPON FINDING OF FRAUD (AUG 1992)
17.	SAACONS 52.0232-4501	INVOICES (AUG 1991)
18.	FAR 52.236-1	PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984)
19.	FAR 52.236-4	PHYSICAL DATA (APR 1984)
20.	DFARS 252.236-7001	CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (DEC 1991)
21.	SAACONS 52.0236-4801	SALVAGE AND SCRAP GOVERNMENT PROPERTY (OCT 1993)
22.	SAACONS 52.0236-4581	AVAILABILITY OF UTILITIES SERVICES (APR 1992)
23.	FAR 52.246-12	INSPECTION OF CONSTRUCTION (AUG 1996)
24.	FAR 52.219-9	SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS SUBCONTRACTING PLAN (AUG 1996)
25.	FAR 52.225-5	BUY AMERICAN ACT--CONSTRUCTION MATERIALS (JUN 1997)
26.	FAR 52.243-7	NOTIFICATION OF CHANGES (APR 1984)
27.	DFARS 252.247-7023	TRANSPORTATION OF SUPPLIES BY SEA (NOV 1995)
28.	FAR 52.252-4	ALTERATIONS IN CONTRACT (APR 1984)
29.	FAR 52.252-6	AUTHORIZED DEVIATIONS IN CLAUSES (APR 1984)
30.	DFARS 252.223-7004	DRUG-FREE WORK FORCE (SEP 1988)
31.	EFARS 52.249-5000	BASIS FOR SETTLEMENT OF PROPOSALS (DEC 1995)
32.	AS-BUILT DRAWINGS (PROGRESS PAYMENT)	

SECTION 00800

SPECIAL CONTRACT REQUIREMENTS

1. FAR 52.204-4 PRINTING/COPYING DOUBLE-SIDED ON RECYCLED PAPER (JUN 1996)

(a) In accordance with Executive Order 12873, dated October 20, 1993, as amended by Executive Order 12995, dated March 25, 1996, the Offeror/Contractor is encouraged to submit paper documents, such as offers, letters, or reports, that are printed/copied double-sided on recycled paper that has at least 20% postconsumer material.

(b) The 20% standard applies to high-speed copies paper, offset paper, forms bond, computer printout paper, and carbonless paper, file folders, white woven envelopes, and other uncoated printed and writing paper, such as writing and office paper, book paper, cotton fiber paper, and cover stock. An alternative to meeting the 20 % postconsumer material standard is 50 % recovered material content of certain industrial by-products.

2. DFARS 252.204-7003 CONTROL OF GOVERNMENT PERSONNEL WORK PRODUCT (APR 1992)

The Contractor's procedures for protecting against unauthorized disclosure of information shall not require Department of Defense employees or members of the Armed Forces to relinquish control of their work products, whether classified or not, to the Contractor.

3. FAR 52.211-10 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1994)

The Contractor shall be required to (a) commence work under this contract within **10** calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 540 calendar days after receipt of notice to proceed. The time stated for completion shall include final cleanup of the premises.

4. FAR 52.211-12 LIQUIDATED DAMAGES--CONSTRUCTION (APR 1984)

(a) If the Contractor fails to complete the work within the time specified in the contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of $1117.00 for each day of delay.

(b) If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

(c) If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

5. FAR 52.211-13 TIME EXTENSIONS (APR 1984)

Notwithstanding any other provisions of this contract, it is mutually understood that the time extensions for changes in the work will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of CONSTRUCTION. The change order granting the time extension may provide that the contract completion date will be extended only for those specific elements so delayed and that the remaining contract completion dates for all other portions of the work will not be altered and may further provide for an equitable readjustment of liquidated damages under the new completion schedule.

6. SAACONS 52.0211.4853 WORK DAYS AND HOURS (APR 1992)

Working hours will normally be between the hours of 7:00 a.m. and 3:30 p.m., excluding Saturdays, Sundays, and federal holidays. If the Contractor desires to work during periods other than above, the Contractor shall make the request to the Contracting Officer three (3) work days in advance. If Government inspection forces are not required or such forces are reasonably available, the Contracting Officer may authorize the Contractor to perform work during periods other than normal duty hours/days. However, if Government inspectors are required to perform in excess of their normal duty hours/days solely for the benefit of the Contractor, the actual cost of inspection at overtime rates will be charged to the Contractor. These adjustments to the contract price may be made periodically as directed by the Contracting Officer.

7. SAACONS 52.0215-4101 ALTERNATE STRUCTURED APPROACH TO WEIGHTED GUIDELINE METHOD FOR CONSTRUCTION CONTRACTS (EFARS 15.973-100) (MAY 1995)

The following alternate structured approach shall be used for all fixed-price construction contract actions.

Factor	Rate	Weight	Value
Degree of risk	20		
Relative difficulty of work	15		
Size of job	15		
Period of performance	15		
Contractor's investment	5		
Assistance by Government	5		
Subcontracting	25		
Total	100%		

Based on the circumstances of the procurement action, each of the above factors shall be weighted from .03 to .12 as indicated below. "Value shall be obtained by multiplying the rate by the weight. The Value column when totaled indicates the fair and reasonable profit percentage under the circumstances of the particular procurement. The profit percentage should be multiplied by the total contract costs, including general and administrative costs.

(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 shall generally have a higher weight than unit price items; other things to consider include the nature of the work and where it is to be performed. Consider the portion of the work to be done by subcontractors, amount and type of labor included in costs, whether the negotiation is before or after performance of the work, etc. Modifications settled before the fact have much greater risk than those settled after the fact. A weight of .03 is appropriate for after the fact equitable adjustments and/or settlements.

(2) Relative Difficulty of Work: If the work is difficult and complex, the weight 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 other things to consider are the nature of the work, by whom it is to be done (i.e., subcontractors, consultants), what is the time schedule.

(3) Size of Job. Work of $100,000 or less shall be weighted at .12. Work estimated between $100,000 and $5,000,000 shall be proportionately weighted from .12 to .05. Work from $5,000,000 to $10,000,000 shall be weighted at .04. Work in excess of $10,000,000 shall be weighted at .03. It should be noted that control of fixed expenses generally improves with increased job magnitude.

(4) Period of Performance. Work not to exceed one month is to be proportionately weighted at .03. Work in excess of 24 months is to be weighted at .12. Durations between one month and 24 months are to be proportionately weighted between .03 and .12.

(5) Contractor's Investment. To be weighted from .03 to .12 on the basis of below average, average and above average. Things to consider include amount of subcontracting, Government-furnished property or data such as surveys, soil tests, method of making progress payments, and any mobilization payment items.

(6) Assistance by Government. To be weighted from .12 to .03 on the basis of average to above average. Consider use of Government-owned property, equipment and facilities, and expediting assistance.

(7) Subcontracting. To be weighted inversely proportional to the amount of subcontracting. Where 80% or more of the work is to be subcontracted use .03. The weighting should be increased proportionately to .12 where all the work is performed by the contractor's own forces.

8. SAACONS 52.0219-4509 SUBCONTRACTING WITH SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESSES (JAN 1996)

Contractors are cautioned that failure of any Contractor to comply in good faith with the Contract Clauses titled (1) Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns or (2) Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan, when applicable, will be a material breach of contract. In order to assist contractors in developing a source list of small, small disadvantaged and/or women-owned small business concerns you are encouraged to contact your minority contractor associates, the local Minority Business Development Agency and the appropriate General Business Service Centers in your Standard Metropolitan Statistical Area. Contractors may obtain addresses of these sources from:

Contractors are cautioned that failure of any Contractor to comply in good faith with the Contract Clauses titled (1) Utilization of Small Business Concerns and Small Disadvantaged Business Concerns or (2) Small Business and Small Disadvantaged Business Subcontracting Plan, when applicable, will be a material breach of contract. In order to assist contractors in developing a source list of small and/or small disadvantaged business concerns you are encouraged to contact your minority contractor associates, the local Minority Business Development Agency and the appropriate General Business Service Centers in your Standard Metropolitan Statistical Area. Contractors may obtain addresses of these sources from:

Write: US Army Engineer District, Los Angeles
ATTN: Contracting Office, Deputy for Small Business
P.O. Box 2711
Los Angeles, California 90053-2325

Or Contact: Mr. Daniel Hanas
Deputy for Small Business
Telephone: (213) 452-3839

9. FAR 52.223-14 TOXIC CHEMICAL RELEASE REPORTING (OCT 1996)

(a) Unless otherwise exempt, the Contractor as owner or operator of a facility used in the performance of this contract shall file by July 1 for the prior calendar year an annual Toxic Chemical Release Inventory Form (Form R) as described in sections 313(a) and (g) of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA)(42 U.S.C. 11023(a) and (g)), and section 6607 of the Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13106). The Contractor shall file, for each facility subject to the Form R filing and reporting requirements, the annual Form R throughout the life of the contract.

(b) A Contractor owned or operated facility used in the performance of this contract is exempt from the requirement to file an annual Form R if --

(1) The facility does not manufacture, process, or otherwise use any toxic chemicals listed under section 313(c) of EPCRA, 42 U.S.C. 11023(c);

(2) The facility does not have 10 or more full-time employees as specified in section 313(b)(1)(A) of EPCRA, 42 U.S.C. 11023(b)(1)(A);

(3) The facility does not meet the reporting thresholds of toxic chemicals established under section 313(f) of EPCRA, 42 U.S.C. 11023(f) (including the alternate thresholds at 40 CFR 372.27, provided an appropriate certification form has been filed with EPA);

(4) The facility does not fall within Standard Industrial Classification Code (SIC) designations 20 through 39 as set forth in 19.102 of the Federal Acquisition Regulation (FAR); or

(5) The facility is not located within any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Northern Mariana Islands, or any other territory or possession over which the United States has jurisdiction.

(c) If the Contractor has certified to be exempt in accordance with one or more of the criteria in paragraph (b) of this clause, and after award of the contract circumstances change so that any one of its owned or operated facilities used in the performance of this contract is no longer exempt--

(1) The Contractor shall notify the Contracting Officer, and

(2) The Contractor, as owner or operator of a facility used in the performance of this contract that is no longer exempt, shall (i) submit a Toxic Chemical Release Inventory Form (Form R) on or before July 1 for the prior calendar year during which the Contractor becomes eligible; and (ii) continue to file the annual Form R for the life of the contract for such facility.

(d) The Contracting Officer may terminate this contract or take other action as appropriate, if the Contractor fails to comply accurately and fully with the EPCRA and PPA toxic chemical release filing and reporting requirements.

(e) Except for acquisitions for commercial items, as defined in FAR Part 2, the Contractor shall--

(1) For competitive subcontracts expected to exceed $100,000 (including all options), include a solicitation provision substantially the same as the provision at FAR 52.223-13, Certification of Toxic Chemical Release Reporting; and

(2) Include in any resultant subcontract exceeding $100,000 (including all options), the substance of this clause, except this paragraph (e).

10. DFARS 252.223-7006 PROHIBITION ON STORAGE AND DISPOSAL OF TOXIC AND HAZARDOUS MATERIALS (APR 1993)

(a) Definitions. As used in this clause--

(1) "Storage" means a non-transitory, semi-permanent or permanent holding, placement, or leaving of material. It does not include a temporary accumulation of a limited quantity of a material used in or a waste generated or resulting from authorized activities, such as servicing, maintenance, or repair of Department of Defense (DoD) items, equipment, or facilities.

(2) "Toxic or hazardous materials" means:

(i) Materials referred to in section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 U.S.C. 9601(14)) and materials designated under section 102 of CERCLA (42. U.S.C. 9602 (40 CFR Part 302);

(ii) Materials that are of an explosive, flammable, or pyrotechnic nature; or

(iii) Materials otherwise identified by the Secretary of Defense as specified in DoD regulations.

(b) In accordance with 10 U.S.C. 2692, the Contractor is prohibited from storing or disposing of non-DoD-owned toxic or hazardous materials on a DoD installation, except to the extent authorized by a statutory exception to 10 U.S.C. 2692 or as authorized by the Secretary of Defense or his designee.

11. SAACONS 52.0223-4803 HAZARDOUS MATERIALS DELIVERED UNDER THIS CONTRACT (MAY 1993)

(a) If any hazardous materials will be delivered under this contract (see Section 00600, FAR 52.223-3, and DFARS 252.223-7001), the Material Safety Data Sheets (MSDS) for locally purchased, nonstandard stock hazardous material will be submitted to the Corps of Engineers Contracting Officer or Contracting Officer's Representative. For all other materials, the MSDS will also be submitted to U.S. Army Environmental Hygiene Agency, ATTN: HSE-OI, Aberdeen Proving Grounds MD 21010.

(b) Hazardous material is defined in Federal Standard No. 313, sold by the General Services Administration Specifications Unit (3FBP-W), 7th & D Streets, SW, Washington DC 20407.

12. FAR 52.228-5 INSURANCE--WORK ON A GOVERNMENT INSTALLATION (JAN 1997)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance of this contract, at least the kinds and minimum amounts of insurance required in the Schedule or elsewhere in the contract.

(b) Before commencing work under this contract, the Contractor shall certify to the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective (1) for such period as the laws of the State in which this contract is to be performed prescribe, or (2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

13. SAACONS 52.0228-4502 MINIMUM INSURANCE REQUIRED (MAY 1993)

The contract clause, FAR 52.228-5, applies to this contract even if the work or any portion of the work is not performed on a Government installation. In accordance with FAR 52.228-5 and FAR 28.307-2, the contractor shall procure and thereafter maintain during the entire period of this performance under this contract the following minimum insurance.

TYPE	AMOUNT
Worker's Compensation and Employer's Liability	Comply with Federal and State worker's comp and occupational disease statutes. Employer's liability of at least $100,000
General Liability (Comprehensive)	Bodily injury liability of at least $500,000 per occurrence.
Automobile Liability (Comprehensive):	
Bodily Injury & Property Damage	At least $200,000 per person and $500,000 per occurrence. At least $20,000 per occurrence.
Longshoremen's and Harbor Worker's Compensation (When applicable by location of contract performance)	Coverage complying with applicable Federal statute (33 USC 901 et seq).

14. EFARS 52.231-5000 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)--EFARS

(a) This statement shall become operative only for negotiated contracts where cost or pricing data is requested, and for modifications to sealed bid or negotiated contracts where cost or pricing data is requested. This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals, and FAR Part 49.

(b) 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 for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, CONSTRUCTION Equipment Ownership and Operating Expense Schedule, Region VII. 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 retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet.

NOTE: See also, Specification Section 01505. A copy of the EP 1110-1-8 is available for review in the Corps of Engineers, Sacramento District Office, 1325 J Street, Library, 8th floor, telephone (916) 557-6657. Copies are available for a nominal charge from the Government Printing Office, telephone (202) 512-1800.

15. FAR 52.232-27 PROMPT PAYMENT FOR CONSTRUCTION CONTRACTS (JUN 1997)

Notwithstanding any other payment terms in this contract, the Government will make invoice payments and contract financing payments under the terms and conditions specified in this clause. Payment shall be considered as being made on the day a check is dated or the date of an electronic funds transfer. Definitions of pertinent terms are set forth in section 32.902 of the Federal Acquisition Regulation. All days referred to in this clause are calendar days, unless otherwise specified. (However, see subparagraph (a)(3) concerning payments due on Saturdays, Sundays, and legal holidays.)

(a) *Invoice payments*--

(1) *Types of invoice payments*. For purposes of this clause, there are several types of invoice payments that may occur under this contract, as follows:

(i) Progress payments, if provided for elsewhere in this contract, based on Contracting Officer approval of the estimated amount and value of work or services performed, including payments for reaching milestones in any project:

(A) The due date for making such payments shall be 14 days after receipt of the payment request by the designated billing office. If the designated billing office fails to annotate the payment request with the actual date of receipt at the time of receipt, the payment due date shall be the 14th day after the date of the Contractor's payment request, provided a proper payment request is received and there is no disagreement over quantity, quality, or Contractor compliance with contract requirements.

(B) The due date for payment of any amounts retained by the Contracting Officer in accordance with the clause at 52.232-5, Payments Under Fixed-Price Construction Contracts, shall be as specified in the contract or, if not specified, 30 days after approval for release to the Contractor by the Contracting Officer.

(ii) Final payments based on completion and acceptance of all work and presentation of release of all claims against the Government arising by virtue of the contract, and payments for partial deliveries that have been accepted by the Government (*e.g.*, each separate building, public work, or other division of the contract for which the price is stated separately in the contract):

(A) The due date for making such payments shall be either the 30th day after receipt by the designated billing office of a proper invoice from the Contractor, or the 30th day after Government acceptance of the work or services completed by the Contractor, whichever is later. If the designated billing office fails to annotate the invoice with the date of actual receipt at the time of receipt, the invoice payment due date shall be the 30th day after the date of the Contractor's invoice, provided a proper invoice is received and there is no disagreement over quantity, quality, or Contractor compliance with contract requirements.

(B) On a final invoice where the payment amount is subject to contract settlement actions (*e.g.*, release of claims), acceptance shall be deemed to have occurred on the effective date of the contract settlement.

(2) *Contractor's invoice*. The Contractor shall prepare and submit invoices to the designated billing office specified in the contract. A proper invoice must include the items listed in subdivisions (a)(2)(i) through (a)(2)(ix) of this clause. If the invoice does not comply with these requirements, it shall be returned within 7 days after the date the designated billing office received the invoice, with a statement of the reasons why it is not a proper invoice. Untimely notification will be taken into account in computing any interest penalty owed the Contractor in the manner described in subparagraph (a)(4) of this clause.

(i) Name and address of the Contractor.

(ii) Invoice date. (The Contractor is encouraged to date invoices as close as possible to the date of mailing or transmission.)

(iii) Contract number or other authorization for work or services performed (including order number and contract line item number).

(iv) Description of work or services performed.

(v) Delivery and payment terms (*e.g.*, prompt payment discount terms).

(vi) Name and address of Contractor official to whom payment is to be sent (must be the same as that in the contract or in a proper notice of assignment).

(vii) Name (where practicable), title, phone number, and mailing address of person to be notified in the event of a defective invoice.

(viii) For payments described in subdivision (a)(1)(i) of this clause, substantiation of the amounts requested and certification in accordance with the requirements of the clause at 52.232-5, Payments Under Fixed-Price Construction Contracts.

(ix) Any other information or documentation required by the contract.

(x) While not required, the Contractor is strongly encouraged to assign an identification number to each invoice.

(3) *Interest penalty*. An interest penalty shall be paid automatically by the designated payment office, without request from the Contractor, if payment is not made by the due date and the conditions listed in subdivisions (a)(3)(i) through (a)(3)(iii) of this clause are met, if applicable. However, when the due date falls on a Saturday, Sunday, or legal holiday when Federal Government offices are closed and Government business is not expected to be conducted, payment may be made on the following business day without incurring a late payment interest penalty.

(i) A proper invoice was received by the designated billing office.

(ii) A receiving report or other Government documentation authorizing payment was processed and there was no disagreement over quantity, quality, Contractor compliance with any contract term or condition, or requested progress payment amount.

(iii) In the case of a final invoice for any balance of funds due the Contractor for work or services performed, the amount was not subject to further contract settlement actions between the Government and the Contractor.

(4) *Computing penalty amount*. The interest penalty shall be at the rate established by the Secretary of the Treasury under section 12 of the Contract Disputes Act of 1978 (41 U.S.C. 611) that is in effect on the day after the due date, except where the interest penalty is prescribed by other governmental authority (*e.g.*, tariffs). This rate is referred to as the "Renegotiation Board Interest Rate," and it is published in the *Federal Register* semiannually on or about January 1 and July 1. The interest penalty shall accrue daily on the invoice principal payment amount approved by the Government until the payment date of such approved principal amount; and will be compounded in 30-day increments inclusive from the first day after the due date through the payment date. That is, interest accrued at the end of any 30-day period will be added to the approved invoice principal payment amount and will be subject to interest penalties if not paid in the succeeding 30-day period. If the designated billing office failed to notify the Contractor of a defective invoice within the periods prescribed in subparagraph (a)(2) of this clause, the due date on the corrected invoice will be adjusted by subtracting from such date the number of days taken beyond the prescribed notification of defects period. Any interest penalty owed the Contractor will be based on this adjusted due date. Adjustments will be made by the designated payment office for errors in calculating interest penalties.

(i) For the sole purpose of computing an interest penalty that might be due the Contractor for payments described in subdivision (a)(1)(ii) of this clause, Government acceptance or approval shall be deemed to have occurred constructively on the 7th day after the Contractor has completed the work or services in accordance with the terms and conditions of the contract. In the event that actual acceptance or approval occurs within the constructive acceptance or approval period, the determination of an interest penalty shall be based on the actual date of acceptance or approval. Constructive acceptance or constructive approval requirements do not apply if there is a disagreement over quantity, quality, or Contractor compliance with a contract provision. These requirements also do not compel Government officials to accept work or services, approve Contractor estimates, perform contract administration functions, or make payment prior to fulfilling their responsibilities.

(ii) The following periods of time will not be included in the determination of an interest penalty:

(A) The period taken to notify the Contractor of defects in invoices submitted to the Government, but this may not exceed 7 days.

(B) The period between the defects notice and resubmission of the corrected invoice by the Contractor.

(C) For incorrect electronic funds transfer (EFT) information, in accordance with the EFT clause of this contract.

(iii) Interest penalties will not continue to accrue after the filing of a claim for such penalties under the clause at 52.233-1, Disputes, or for more than 1 year. Interest penalties of less than $1 need not be paid.

(iv) Interest penalties are not required on payment delays due to disagreement between the Government and the Contractor over the payment amount or other issues involving contract compliance, or on amounts temporarily withheld or retained in accordance with the terms of the contract. Claims involving disputes, and any interest that may be payable, will be resolved in accordance with the clause at 52.233-1, Disputes.

(5) *Prompt payment discounts*. An interest penalty also shall be paid automatically by the designated payment office, without request from the Contractor, if a discount for prompt payment is taken improperly. The interest penalty will be calculated on the amount of discount taken for the period beginning with the first day after the end of the discount period through the date when the Contractor is paid.

(6) *Additional interest penalty*. (i) A penalty amount, calculated in accordance with subdivision (a)(6)(iii) of this clause, shall be paid in addition to the interest penalty amount if the Contractor--

(A) Is owed an interest penalty of $1 or more;

(B) Is not paid the interest penalty within 10 days after the date the invoice amount is paid; and

(C) Makes a written demand to the designated payment office for additional penalty payment, in accordance with subdivision (a)(6)(ii) of this clause, postmarked not later than 40 days after the date the invoice amount is paid.

(ii)(A) Contractors shall support written demands for additional penalty payments with the following data. No additional data shall be required. Contractors shall--

(*1*) Specifically assert that late payment interest is due under a specific invoice, and request payment of all overdue late payment interest penalty and such additional penalty as may be required;

(*2*) Attach a copy of the invoice on which the unpaid late payment interest was due; and

(*3*) State that payment of the principal has been received, including the date of receipt.

(B) Demands must be postmarked on or before the 40th day after payment was made, except that--

(*1*) If the postmark is illegible or nonexistent, the demand must have been received and annotated with the date of receipt by the designated payment office on or before the 40th day after payment was made; or

(*2*) If the postmark is illegible or nonexistent and the designated payment office fails to make the required annotation, the demand's validity will be determined by the date the Contractor has placed on the demand; provided such date is no later than the 40th day after payment was made.

(iii)(A) The additional penalty shall be equal to 100 percent of any original late payment interest penalty except--

(*1*) The additional penalty shall not exceed $5,000;

(*2*) The additional penalty shall never be less than $25; and

(*3*) No additional penalty is owed if the amount of the underlying interest penalty is less than $1.

(B) If the interest penalty ceases to accrue in accordance with the limits stated in subdivision (a)(4)(iii) of this clause, the amount of the additional penalty shall be calculated on the amount of interest penalty that would have accrued in the absence of these limits, subject to the overall limits on the additional penalty specified in subdivision (a)(6)(iii)(A) of this clause.

(C) For determining the maximum and minimum additional penalties, the test shall be the interest penalty due on each separate payment made for each separate contract. The maximum and minimum additional penalty shall not be based upon individual invoices unless the invoices are paid separately. Where payments are consolidated for disbursing purposes, the maximum and minimum additional penalty determination shall be made separately for each contract therein.

(D) The additional penalty does not apply to payments regulated by other Government regulations (*e.g.*, payments under utility contracts subject to tariffs and regulation).

(b) *Contract financing payments*--(1) *Due dates for recurring financing payments*. If this contract provides for contract financing, requests for payment shall be submitted to the designated billing office as specified in this contract or as directed by the Contracting Officer. Contract financing payments shall be made on the [*insert day as prescribed by Agency head; if not prescribed, insert 30th day*] day after receipt of a proper contract financing request by the designated billing office. In the event that an audit or other review of a specific financing request is required to ensure compliance with the terms and conditions of the contract, the designated payment office is not compelled to make payment by the due date specified.

(2) *Due dates for other contract financing*. For advance payments, loans, or other arrangements that do not involve recurring submissions of contract financing requests, payment shall be made in accordance with the corresponding contract terms or as directed by the Contracting Officer.

(3) *Interest penalty not applicable*. Contract financing payments shall not be assessed an interest penalty for payment delays.

(c) *Subcontract clause requirements*. The Contractor shall include in each subcontract for property or services (including a material supplier) for the purpose of performing this contract the following:

(1) *Prompt payment for subcontractors*. A payment clause that obligates the Contractor to pay the subcontractor for satisfactory performance under its subcontract not later than 7 days from receipt of payment out of such amounts as are paid to the Contractor under this contract.

(2) *Interest for subcontractors*. An interest penalty clause that obligates the Contractor to pay to the subcontractor an interest penalty for each payment not made in accordance with the payment clause--

(i) For the period beginning on the day after the required payment date and ending on the date on which payment of the amount due is made; and

(ii) Computed at the rate of interest established by the Secretary of the Treasury, and published in the *Federal Register*, for interest payments under section 12 of the Contract Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty.

(3) *Subcontractor clause flowdown*. A clause requiring each subcontractor to include a payment clause and an interest penalty clause conforming to the standards set forth in subparagraphs (c)(1) and (c)(2) of this clause in each of its subcontracts, and to require each of its subcontractors to include such clauses in their subcontracts with each lower-tier subcontractor or supplier.

(d) *Subcontract clause interpretation*. The clauses required by paragraph (c) of this clause shall not be construed to impair the right of the Contractor or a subcontractor at any tier to negotiate, and to include in their subcontract, provisions that--

(1) *Retainage permitted*. Permit the Contractor or a subcontractor to retain (without cause) a specified percentage of each progress payment otherwise due to a subcontractor for satisfactory performance under the subcontract without incurring any obligation to pay a late payment interest penalty, in accordance with terms and conditions agreed to by the parties to the subcontract, giving such recognition as the parties deem appropriate to the ability of a subcontractor to furnish a performance bond and a payment bond;

(2) *Withholding permitted*. Permit the Contractor or subcontractor to make a determination that part or all of the subcontractor's request for payment may be withheld in accordance with the subcontract agreement; and

(3) *Withholding requirements*. Permit such withholding without incurring any obligation to pay a late payment penalty if--

(i) A notice conforming to the standards of paragraph (g) of this clause previously has been furnished to the subcontractor; and

(ii) A copy of any notice issued by a Contractor pursuant to subdivision (d)(3)(i) of this clause has been furnished to the Contracting Officer.

(e) *Subcontractor withholding procedures*. If a Contractor, after making a request for payment to the Government but before making a payment to a subcontractor for the subcontractor's performance covered by the payment request, discovers that all or a portion of the payment otherwise due such subcontractor is subject to withholding from the subcontractor in accordance with the subcontract agreement, then the Contractor shall--

(1) *Subcontractor notice*. Furnish to the subcontractor a notice conforming to the standards of paragraph (g) of this clause as soon as practicable upon ascertaining the cause giving rise to a withholding, but prior to the due date for subcontractor payment;

(2) *Contracting Officer notice*. Furnish to the Contracting Officer, as soon as practicable, a copy of the notice furnished to the subcontractor pursuant to subparagraph (e)(1) of this clause;

(3) *Subcontractor progress payment reduction*. Reduce the subcontractor's progress payment by an amount not to exceed the amount specified in the notice of withholding furnished under subparagraph (e)(1) of this clause;

(4) *Subsequent subcontractor payment*. Pay the subcontractor as soon as practicable after the correction of the identified subcontract performance deficiency, and--

(i) Make such payment within--

(A) Seven days after correction of the identified subcontract performance deficiency (unless the funds therefor must be recovered from the Government because of a reduction under subdivision (e)(5)(i)) of this clause; or

(B) Seven days after the Contractor recovers such funds from the Government; or

(ii) Incur an obligation to pay a late payment interest penalty computed at the rate of interest established by the Secretary of the Treasury, and published in the *Federal Register*, for interest payments under section 12 of the Contracts Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty;

(5) *Notice to Contracting Officer*. Notify the Contracting Officer upon--

(i) Reduction of the amount of any subsequent certified application for payment; or

(ii) Payment to the subcontractor of any withheld amounts of a progress payment, specifying--

(A) The amounts withheld under subparagraph (e)(1) of this clause; and

(B) The dates that such withholding began and ended; and

(6) *Interest to Government*. Be obligated to pay to the Government an amount equal to interest on the withheld payments (computed in the manner provided in 31 U.S.C. 3903(c)(1)), from the 8th day after receipt of the withheld amounts from the Government until--

(i) The day the identified subcontractor performance deficiency is corrected; or

(ii) The date that any subsequent payment is reduced under subdivision (e)(5)(i) of this clause.

(f) *Third-party deficiency reports*--(1) *Withholding from subcontractor*. If a Contractor, after making payment to a first-tier subcontractor, receives from a supplier or subcontractor of the first-tier subcontractor (hereafter referred to as a "second-tier subcontractor") a written notice in accordance with section 2 of the Act of August 24, 1935 (40 U.S.C. 270b, Miller Act), asserting a deficiency in such first-tier subcontractor's performance under the contract for which the Contractor may be ultimately liable, and the Contractor determines that all or a portion of future payments otherwise due such first-tier subcontractor is subject to withholding in accordance with the subcontract agreement, the Contractor may, without incurring an obligation to pay an interest penalty under subparagraph (e)(6) of this clause--

(i) Furnish to the first-tier subcontractor a notice conforming to the standards of paragraph (g) of this clause as soon as practicable upon making such determination; and

(ii) Withhold from the first-tier subcontractor's next available progress payment or payments an amount not to exceed the amount specified in the notice of withholding furnished under subdivision (f)(1)(i) of this clause.

(2) *Subsequent payment or interest charge*. As soon as practicable, but not later than 7 days after receipt of satisfactory written notification that the identified subcontract performance deficiency has been corrected, the Contractor shall--

(i) Pay the amount withheld under subdivision (f)(1)(ii) of this clause to such first-tier subcontractor; or

(ii) Incur an obligation to pay a late payment interest penalty to such first-tier subcontractor computed at the rate of interest established by the Secretary of the Treasury, and published in the *Federal Register*, for interest payments under section 12 of the Contracts Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty.

(g) *Written notice of subcontractor withholding*. A written notice of any withholding shall be issued to a subcontractor (with a copy to the Contracting Officer of any such notice issued by the Contractor), specifying--

(1) The amount to be withheld;

(2) The specific causes for the withholding under the terms of the subcontract; and

(3) The remedial actions to be taken by the subcontractor in order to receive payment of the amounts withheld.

(h) *Subcontractor payment entitlement*. The Contractor may not request payment from the Government of any amount withheld or retained in accordance with paragraph (d) of this clause until such time as the Contractor has determined and certified to the Contracting Officer that the subcontractor is entitled to the payment of such amount.

(i) *Prime-subcontractor disputes*. A dispute between the Contractor and subcontractor relating to the amount or entitlement of a subcontractor to a payment or a late payment interest penalty under a clause included in the subcontract pursuant to paragraph (c) of this clause does not constitute a dispute to which the United States is a party. The United States may not be interpleaded in any judicial or administrative proceeding involving such a dispute.

(j) *Preservation of prime-subcontractor rights*. Except as provided in paragraph (i) of this clause, this clause shall not limit or impair any contractual, administrative, or judicial remedies otherwise available to the Contractor or a subcontractor in the event of a dispute involving late payment or nonpayment by the Contractor or deficient subcontract performance or nonperformance by a subcontractor.

(k) *Non-recourse for prime contractor interest penalty*. The Contractor's obligation to pay an interest penalty to a subcontractor pursuant to the clauses included in a subcontract under paragraph (c) of this clause shall not be construed to be an obligation of the United States for such interest penalty. A cost-reimbursement claim may not include any amount for reimbursement of such interest penalty.

16. DFARS 252.232-7006 REDUCTION OR SUSPENSION OF CONTRACT PAYMENTS UPON FINDING OF FRAUD (AUG 1992)

(a) 10 U.S.C. 2307(e) permits the head of the agency to reduce or suspend further payments upon a written determination by the agency head that substantial evidence exists that the Contractor's request for advance, partial, or progress payments is based on fraud. The provisions of 10 U.S.C. 2307(e) are in addition to any other rights or remedies provided the Government by law or under contract.

(b) Actions taken by the Government in accordance with 10 U.S.C. 2307(e) shall not constitute an excusable delay under the Default clause of this contract or otherwise relieve the Contractor of its obligations to perform under this contract.

17. SAACONS 52.0232-4501 INVOICES (AUG 1991)

The Government shall pay the Contractor upon submission of proper invoices for supplies delivered and accepted or services rendered and accepted for the portion of work actually performed under this contract. Invoices will be submitted in quadruplicate to the address in Block 26, SF1442, which will be completed at time of award. Invoices shall be submitted on ENG Form 93 which will be provided to the Contractor by the Government

18. FAR 52.236-1 PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984)

The Contractor shall perform on the site, and with its own organization, work equivalent to at least <u>twenty</u> percent of the total amount of work to be performed under the contract. This percentage may be reduced by a supplemental agreement to this contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

19. FAR 52.236-4 PHYSICAL DATA (APR 1984)

Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) The indications of physical conditions on the drawings and in the specifications are the result of site investigations by the Government.

(b) Weather conditions: The Contractor shall satisfy himself/herself as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any U.S. Weather Bureau Office.

(c) Transportation Facilities: The Southern Pacific Company serves the Government sidings along Utah Avenue between Washington and Nebraska Avenues. The Contractor will be permitted to use one of these sidings for delivery of materials and equipment to the work. The Contractor shall make his/her own investigations of the condition of available public and base roads and of the clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the site of the work. It shall be the Contractor's responsibility to construct and maintain, at Contractor's expense, any haul roads required for construction operations.

20. DFARS 252.236-7001 CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (DEC 1991)

(a) The Government--

(1) Will provide the Contractor, without charge, one set of large-scale contract drawings and specifications except publications incorporated into the technical provisions by reference;

(2) Will furnish additional sets on request, for the cost of reproduction; and

(3) May, at its option, furnish the Contractor one set of reproducibles, or half-size drawings, in lieu of the drawings in paragraph (a)(1) of this clause.

(b) The Contractor shall--

(1) Check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies; and

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b).

(c) Large scale drawings shall, in general, govern small scale drawings. Figures marked on drawings shall, in general, be followed in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work, but shall be performed as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified on the following index of drawings:

Drawing File No.
221-25-1170

Seq. No.	Sheet No.	Description	Rev. No.
1	G1.0	TITLE SHEET	
2	G2.0	SCHEDULE OF DRAWINGS	
3	G3.0	PROJECT LOCATION MAPS	
4	G4.0	METRIC CONVERSION CHARTS	
5	C1.0	TOPOGRAPHY INDEX	
6	C1.1	TOPOGRAPHY	
7	C1.2	TOPOGRAPHY	
8	C1.3	TOPOGRAPHY	
9	C1.4	TOPOGRAPHY	
10	C2.0	LOGS AND LOCATION OF EXPLORATIONS	
11	C2.1	LOGS OF EXPLORATIONS	
12	C2.2	LOGS OF EXPLORATIONS	
13	C3.0	DEMOLITION PLAN	
14	C4.0	SITE PLAN	
15	C4.1	SITE PLAN	
16	C5.0	PAVING AND GRADING PLAN	
17	C5.1	PAVING AND GRADING PLAN	
18	C5.2	PAVING AND GRADING PLAN	
19	C6.0	UTILITY PLAN	
20	C6.1	UTILITY PLAN	
21	C7.0	CROSS SECTION	
22	C9.0	DETAILS	
23	C9.1	DETAILS	
24	C9.2	DETAILS	
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27	L1.1	LANDSCAPE LAYOUT PLAN (PARKING AREA)	
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STANDARD DRAWINGS

(Attached to SPECIFICATION SECTION: GENERAL REQUIREMENTS)

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Safety Sign	80-25-707
Hard Hat Sign	80-25-774

21. SAACONS 52.0236-4801 SALVAGE AND SCRAP GOVERNMENT PROPERTY (OCT 1993)

(a) "Government property" means all property owned by or leased to the Government or acquired by the Government under the terms of the contract. It includes both Government-furnished property and contractor-acquired property.

(b) "Salvage" means Government property in possession of a contractor, including subcontractors, that, because of its worn, damaged, deteriorated, or incomplete condition or specialized nature, has no reasonable prospect of sale or use as serviceable property without major repairs, but has some value in excess of its scrap value.

(c) "Scrap" means Government personal property that has no value except for its basic material content.

(d) In accordance with FAR 45.505-8 the Contractor shall maintain records of all scrap and salvage generated from this contract. The Contractor's records shall contain the following information:

(1) Contract Number

(2) Description of salvageable items or classification (material content) of scrap

(3) Quantity on hand

(e) The Contractor shall provide final accounting and disposition recommendations of all Government property not consumed in performing this contract or delivered to the Government including salvage and scrap. The Government will review the Contractor's records and shall cause correction if the Government disagrees with the classification of items as salvage or scrap. The Contractor shall dispose of the items as directed by the Contracting Officer. Items designated as scrap (agreed to by the Contracting Officer) shall be retained by the Contractor; its disposition shall be the responsibility of the Contractor. See Specification Section 01505, paragraph entitled "Scrap Material". Items designated as salvageable items (agreed to by the Contracting Officer) shall be turned over to the Government.

22. SAACONS 52.0236-4581 AVAILABILITY OF UTILITIES SERVICES (APR 1992)

All reasonably required amounts of water, electricity, and other utilities essential to contract performance will be made available to the contractor at no cost to the contractor from existing systems, outlets and supplies. All temporary connections, outlets and distribution lines, as may be required, shall be installed, maintained and removed by the Contractor at Contractor's expense; removal shall be before final acceptance of the work by the Government. The Contractor shall carefully conserve any utilities furnished without charge.

23. FAR 52.246-12 INSPECTION OF CONSTRUCTION (AUG 1996)

(a) Definition. "Work" includes, but is not limited to, materials, workmanship, and manufacture and fabrication of components.

(b) The Contractor shall maintain an adequate inspection system and perform such inspections as will ensure that the work performed under the contract conforms to contract requirements. The Contractor shall maintain complete inspection records and make them available to the Government. All work shall be conducted under the general direction of the Contracting Officer and is subject to Government inspection and test at all places and at all reasonable times before acceptance to ensure strict compliance with the terms of the contract.

(c) Government inspections and tests are for the sole benefit of the Government and do not--

(1) Relieve the Contractor of responsibility for providing adequate quality control measures;

(2) Relieve the Contractor of responsibility for damage to or loss of the material before acceptance;

(3) Constitute or imply acceptance; or

(4) Affect the continuing rights of the Government after acceptance of the completed work under paragraph (i) below.

(d) The presence or absence of a Government inspector does not relieve the Contractor from any contract requirement, nor is the inspector authorized to change any term or condition of the specification without the Contracting Officer's written authorization.

(e) The Contractor shall promptly furnish, at no increase in contract price, all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by the Contracting Officer. The Government may charge to the Contractor any additional cost of inspection or test when work is not ready at the time specified by the Contractor for inspection or test, or when prior rejection makes reinspection or retest necessary. The Government shall perform all inspections and tests in a manner that will not unnecessarily delay the work. Special, full size, and performance tests shall be performed as described in the contract.

(f) The Contractor shall, without charge, replace or correct work found by the Government not to conform to contract requirements, unless in the public interest the Government consents to accept the work with an appropriate adjustment in contract price. The Contractor shall promptly segregate and remove rejected material from the premises.

(g) If the Contractor does not promptly replace or correct rejected work, the Government may (1) by contract or otherwise, replace or correct the work and charge the cost to the Contractor or (2) terminate for default the Contractor's right to proceed.

(h) If, before acceptance of the entire work, the Government decides to examine already completed work by removing it or tearing it out, the Contractor, on request, shall promptly furnish all necessary facilities, labor, and material. If the work is found to be defective or nonconforming in any material respect due to the fault of the Contractor or its subcontractors, the Contractor shall defray the expenses of the examination and of satisfactory reconstruction. However, if the work is found to meet contract requirements, the Contracting Officer shall make an equitable adjustment for the additional services involved in the examination and reconstruction, including, if completion of the work was thereby delayed, an extension of time.

(i) Unless otherwise specified in the contract, the Government shall accept, as promptly as practicable after completion and inspection, all work required by the contract or that portion of the work the Contracting Officer determines can be accepted separately. Acceptance shall be final and conclusive except for latent defects, fraud, gross mistakes amounting to fraud, or the Government's rights under any warranty or guarantee.

24. FAR 52.219-9 I SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS SUBCONTRACTING PLAN (AUG 1996)--ALTERNATE I (OCT 1995)

(a) This clause does not apply to small business concerns.

(b) "Commercial product," as used in this clause, means a product in regular production that is sold in substantial quantities to the general public and/or industry at established catalog or market prices. It also means a product which, in the opinion of the Contracting Officer, differs only insignificantly from the Contractor's commercial product.

"Subcontract," as used in this clause, means any agreement (other than one involving an employer-employee relationship) entered into by a Federal Government prime Contractor or subcontractor calling for supplies or services required for performance of the contract or subcontract.

(c) The apparent low bidder, upon request by the Contracting Officer, shall submit a subcontracting plan, where applicable, which separately addresses subcontracting with small business concerns, with small disadvantaged business concerns and with women-owned small business concerns. If the bidder is submitting an individual contract plan, the plan must separately address subcontracting with small business concerns, small disadvantaged business concerns, and women-owned small business concerns with a separate part for the basic contract and separate parts for each option (if any). The plan shall be included in and made a part of the resultant contract. The subcontracting plan shall be submitted within the time specified by the Contracting Officer. Failure to submit the subcontracting plan shall make the bidder ineligible for the award of a contract.

(d) The offeror's subcontracting plan shall include the following:

(1) Goals, expressed in terms of percentages of total planned subcontracting dollars, for the use of small business concerns, small disadvantaged business concerns and women-owned small business concerns as subcontractors. The offeror shall include all subcontracts that contribute to contract performance, and may include a proportionate share of products and services that are normally allocated as indirect costs.

(2) A statement of--

(i) Total dollars planned to be subcontracted;

(ii) Total dollars planned to be subcontracted to small business concerns; and

(iii) Total dollars planned to be subcontracted to small disadvantaged business concerns; and

(iv) Total dollars planned to be subcontracted to women-owned small business concerns.

(3) A description of the principal types of supplies and services to be subcontracted, and an identification of the types planned for subcontracting to (i) small business concerns, (ii) small disadvantaged business concerns and (iii) women-owned small business concerns.

(4) A description of the method used to develop the subcontracting goals in paragraph (d)(1) of this clause.

(5) A description of the method used to identify potential sources for solicitation purposes (e.g., existing company source lists, the Procurement Automated Source System (PASS) of the Small Business Administration, the National Minority Purchasing Council Vendor Information Service, the Research and Information Division of the Minority Business Development Agency in the Department of Commerce, or small, small disadvantaged and women-owned small business concerns trade associations). A firm may rely on the information contained in PASS as an accurate representation of a concern's size and ownership characteristics for purposes of maintaining a small business source list. A firm may rely on PASS as its small business source list. Use of the PASS as its source list does not relieve a firm of its responsibilities (i.e., outreach, assistance, counseling, publicizing subcontracting opportunities) in this clause.

(6) A statement as to whether or not the offeror included indirect costs in establishing subcontracting goals, and a description of the method used to determine the proportionate share of indirect costs to be incurred with (i) small business concerns, (ii) small disadvantaged business concerns, and (iii) women-owned small business concerns.

(7) The name of the individual employed by the offeror who will administer the offeror's subcontracting program, and a description of the duties of the individual.

(8) A description of the efforts the offeror will make to assure that small, small disadvantaged and women-owned small business concerns have an equitable opportunity to compete for subcontracts.

(9) Assurances that the offeror will include the clause in this contract entitled "Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns" in all subcontracts that offer further subcontracting opportunities, and that the offeror will require all subcontractors (except small business concerns) who receive subcontracts in excess of $500,000 ($1,000,000 for construction of any public facility) to adopt a plan similar to the plan agreed to by the offeror.

(10) Assurances that the offeror will (i) cooperate in any studies or surveys as may be required, (ii) submit periodic reports in order to allow the Government to determine the extent of compliance by the offeror with the subcontracting plan, (iii) submit Standard Form (SF) 294, Subcontracting Report for Individual Contracts, and/or SF 295, Summary Subcontract Report, in accordance with the instructions on the forms, and (iv) ensure that its subcontractors agree to submit Standard Forms 294 and 295.

(11) A recitation of the types of records the offeror will maintain to demonstrate procedures that have been adopted to comply with the requirements and goals in the plan, including establishing source lists; and a description of its efforts to locate small, small disadvantaged and women-owned small business concerns and award subcontracts to them. The records shall include at least the following (on a plant-wide or company-wide basis, unless otherwise indicated):

(i) Source lists (e.g., PASS), guides, and other data that identify small, small disadvantaged and women-owned small business concerns.

(ii) Organizations contacted in an attempt to locate sources that are small, small disadvantaged or women-owned small business concerns.

(iii) Records on each subcontract solicitation resulting in an award of more than $100,000, indicating (A) whether small business concerns were solicited and if not, why not, (B) whether small disadvantaged business concerns were solicited and if not, why not, (C) whether women-owned small business concerns were solicited and if not, why not, and (D) if applicable, the reason award was not made to a small business concern.

(iv) Records of any outreach efforts to contact (A) trade associations, (B) business development organizations, and (C) conferences and trade fairs to locate small, small disadvantaged and women-owned small business sources.

(v) Records of internal guidance and encouragement provided to buyers through (A) workshops, seminars, training, etc., and (B) monitoring performance to evaluate compliance with the programs's requirements.

(vi) On a contract-by-contract basis, records to support award data submitted by the offeror to the Government, including the name, address, and business size of each subcontractor. Contractors having company or division-wide annual plans need not comply with this requirement.

(e) In order to effectively implement this plan to the extent consistent with efficient contract performance, the Contractor shall perform the following functions:

(1) Assist small, small disadvantaged and women-owned small business concerns by arranging solicitations, time for the preparation of bids, quantities, specifications, and delivery schedules so as to facilitate the participation by such concerns. Where the contractor's lists of potential small, small disadvantaged and women-owned small business subcontractors are excessively long, reasonable effort shall be made to give all such small business concerns an opportunity to compete over a period of time.

(2) Provide adequate and timely consideration of the potentialities of small, small disadvantaged and women-owned small business concerns in all "make-or-buy" decisions.

(3) Counsel and discuss subcontracting opportunities with representatives of small, small disadvantaged and women-owned small business firms.

(4) Provide notice to subcontractors concerning penalties and remedies for misrepresentations of business status as small, small disadvantaged or women-owned small business for the purpose of obtaining a subcontract that is to be included as part or all of a goal contained in the Contractor's subcontracting plan.

(f) A master subcontracting plan on a plant or division-wide basis which contains all the elements required by (d) of this clause, except goals, may be incorporated by reference as a part of the subcontracting plan required of the offeror by this clause; provided, (1) the master plan has been approved, (2) the offeror ensures that the plan is updated as necessary and provides copies of the approved master plan, including evidence of its approval, to the Contracting Officer, and (3) goals and any deviations from the master plan deemed necessary by the Contracting Officer to satisfy the requirements of this contract are set forth in the individual subcontracting plan.

(g)(1) If a commercial product is offered, the subcontracting plan required by this clause may relate to the offeror's production generally, for both commercial and noncommercial products, rather than solely to the Government contract. In these cases, the offeror shall, with the concurrence of the Contracting Officer, submit one company-wide or division-wide annual plan.

(2) The annual plan shall be reviewed for approval by the agency awarding the offeror its first prime contract requiring a subcontracting plan during the fiscal year, or by an agency satisfactory to the Contracting Officer.

(3) The approved plan shall remain in effect during the offeror's fiscal year for all of the offeror's commercial products.

(h) Prior compliance of the offeror with other such subcontracting plans under previous contracts will be considered by the Contracting Officer in determining the responsibility of the offeror for award of the contract.

(i) The failure of the Contractor or subcontractor to comply in good faith with (1) the clause of this contract entitled "Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns," or (2) an approved plan required by this clause, shall be a material breach of the contract.

25. FAR 52.225-5 BUY AMERICAN ACT--CONSTRUCTION MATERIALS (JUN 1997)

(a) *Definitions*. As used in this clause--

"Components" means those articles, materials, and supplies incorporated directly into construction materials.

"Construction material" means an article, material, or supply brought to the construction site for incorporation into the building or work. Construction material also includes an item brought to the site pre-assembled from articles, materials or supplies. However, emergency life safety systems, such as emergency lighting, fire alarm, and audio evacuation systems, which are discrete systems incorporated into a public building or work and which are produced as a complete system, shall be evaluated as a single and distinct construction material regardless of when or how the individual parts or components of such systems are delivered to the construction site.

"Domestic construction material" means (1) an unmanufactured construction material mined or produced in the United States, or (2) a construction material manufactured in the United States, if the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind as the construction materials determined to be unavailable pursuant to subparagraph 25.202(a)(2) of the Federal Acquisition Regulation (FAR) shall be treated as domestic.

(b)(1) The Buy American Act (41 U.S.C. 10a-10d) requires that only domestic construction material be used in performing this contract, except as provided in paragraphs (b)(2) and (b)(3) of this clause.

(2) This requirement does not apply to the excepted construction material or components listed by the Government as follows:

None

[List applicable excepted materials or indicate "None"]

(3) Other foreign construction material may be added to the list in paragraph (b)(2) of this clause if the Government determines that--

(i) The cost would be unreasonable (the cost of a particular domestic construction material shall be determined to be unreasonable when the cost of such material exceeds the cost of foreign material by more than 6 percent, unless the agency head determines a higher percentage to be appropriate);

(ii) The application of the restriction of the Buy American Act to a particular construction material would be impracticable or inconsistent with the public interest; or

(iii) The construction material is not mined, produced, or manufactured in the United States in sufficient and reasonably available commercial quantities of a satisfactory quality.

(4) The Contractor agrees that only domestic construction material will be used by the Contractor, subcontractors, material men, and suppliers in the performance of this contract, except for foreign construction materials, if any, listed in paragraph (b)(2) of this clause.

(c) *Request for determination*.

(1) Contractors requesting to use foreign construction material under paragraph (b)(3) of this clause shall provide adequate information for Government evaluation of the request for a determination regarding the inapplicability of the Buy American Act. Each submission shall include a description of the foreign and domestic construction materials, including unit of measure, quantity, price, time of delivery or availability, location of the construction project, name and address of the proposed contractor, and a detailed justification of the reason for use of foreign materials cited in accordance with paragraph (b)(3) of this clause. A submission based on unreasonable cost shall include a reasonable survey of the market and a completed price comparison table in the format in paragraph (d) of this clause. The price of construction material shall include all delivery costs to the construction site and any applicable duty (whether or not a duty-free certificate may be issued).

(2) If the Government determines after contract award that an exception to the Buy American Act applies, the contract shall be modified to allow use of the foreign construction material, and adequate consideration shall be negotiated. However, when the basis for the exception is the unreasonable price of a domestic construction material, adequate consideration shall not be less than the differential established in paragraph (b)(3)(i) of this clause.

(3) If the Government does not determine that an exception to the Buy American Act applies, the use of that particular foreign construction material will be a failure to comply with the Act.

(d) For evaluation of requests under paragraph (c) of this clause based on unreasonable cost, the following information and any applicable supporting data based on the survey of suppliers shall be included in the request:

FOREIGN AND DOMESTIC CONSTRUCTION
MATERIALS PRICE COMPARISON

CONSTRUCTION MATERIAL DESCRIPTION	UNIT OF MEASURE	QUANTITY	PRICE (DOLLARS)*
Item 1:			
Foreign construction material	_____	_____	_____
Domestic construction material	_____	_____	_____
Item 2:			
Foreign construction			

material	_____	_____	_____
Domestic construction material	_____	_____	_____

[List name, address telephone number, and contact for suppliers surveyed. Attach copy of response; if oral, attach summary.]
[Include other applicable supporting information.]
*[*Include all delivery costs to the construction site and any applicable duty (whether or not a duty-free entry certificate is issued).]*

26. FAR 52.243-7 NOTIFICATION OF CHANGES (APR 1984)

(a) Definitions. "Contracting Officer," as used in this clause, does not include any representative of the Contracting Officer. "Specifically authorized representative (SAR)," as used in this clause, means any person the Contracting Officer has so designated by written notice (a copy of which shall be provided to the Contractor) which shall refer to this subparagraph and shall be issued to the designated representative before the SAR exercises such authority.

(b) Notice. The primary purpose of this clause is to obtain prompt reporting of Government conduct that the Contractor considers to constitute a change to this contract. Except for changes identified as such in writing and signed by the Contracting Officer, the Contractor shall notify the Administrative Contracting Officer in writing promptly, within 14 calendar days from the date that the Contractor identifies any Government conduct (including actions, inactions, and written or oral communications) that the Contractor regards as a change to the contract terms and conditions. On the basis of the most accurate information available to the Contractor, the notice shall state--

(1) The date, nature, and circumstances of the conduct regarded as a change;

(2) The name, function, and activity of each Government individual and Contractor official or employee involved in or knowledgeable about such conduct;

(3) The identification of any documents and the substance of any oral communication involved in such conduct;

(4) In the instance of alleged acceleration of scheduled performance or delivery, the basis upon which it arose;

(5) The particular elements of contract performance for which the Contractor may seek an equitable adjustment under this clause, including--

(i) What contract line items have been or may be affected by the alleged change;

(ii) What labor or materials or both have been or may be added, deleted, or wasted by the alleged change;

(iii) To the extent practicable, what delay and disruption in the manner and sequence of performance and effect on continued performance have been or may be caused by the alleged change;

(iv) What adjustments to contract price, delivery schedule, and other provisions affected by the alleged change are estimated; and

(6) The Contractor's estimate of the time by which the Government must respond to the Contractor's notice to minimize cost, delay or disruption of performance.

(c) Continued performance. Following submission of the notice required by (b) above, the Contractor shall diligently continue performance of this contract to the maximum extent possible in accordance with its terms and conditions as construed by the Contractor, unless the notice reports a direction of the Contracting Officer or a communication from a SAR of the Contracting Officer, in either of which events the Contractor shall continue performance; provided, however, that if the Contractor regards the direction

or communication as a change as described in (b) above, notice shall be given in the manner provided. All directions, communications, interpretations, orders and similar actions of the SAR shall be reduced to writing promptly and copies furnished to the Contractor and to the Contracting Officer. The Contracting Officer shall promptly countermand any action which exceeds the authority of the SAR.

(d) Government response. The Contracting Officer shall promptly, within 14 calendar days after receipt of notice, respond to the notice in writing. In responding, the Contracting Officer shall either--

(1) Confirm that the conduct of which the Contractor gave notice constitutes a change and when necessary direct the mode of further performance;

(2) Countermand any communication regarded as a change;

(3) Deny that the conduct of which the Contractor gave notice constitutes a change and when necessary direct the mode of further performance; or

(4) In the event the Contractor's notice information is inadequate to make a decision under (1), (2), or (3) above, advise the Contractor what additional information is required, and establish the date by which it should be furnished and the date thereafter by which the Government will respond.

(e) Equitable adjustments.

(1) If the Contracting Officer confirms that Government conduct effected a change as alleged by the Contractor, and the conduct causes an increase or decrease in the Contractor's cost of, or the time required for, performance of any part of the work under this contract, whether changed or not changed by such conduct, an equitable adjustment shall be made--

(i) In the contract price or delivery schedule or both; and

(ii) In such other provisions of the contract as may be affected.

(2) The contract shall be modified in writing accordingly. In the case of drawings, designs or specifications which are defective and for which the Government is responsible, the equitable adjustment shall include the cost and time extension for delay reasonably incurred by the Contractor in attempting to comply with the defective drawings, designs or specifications before the Contractor identified, or reasonably should have identified, such defect. When the cost of property made obsolete or excess as a result of a change confirmed by the Contracting Officer under this clause is included in the equitable adjustment, the Contracting Officer shall have the right to prescribe the manner of disposition of the property. The equitable adjustment shall not include increased costs or time extensions for delay resulting from the Contractor's failure to provide notice or to continue performance as provided, respectively, in (b) and (c) above.

27. DFARS 252.247-7023 TRANSPORTATION OF SUPPLIES BY SEA (NOV 1995)

(a) Definitions. As used in this clause--

(1) "Components" means articles, materials, and supplies incorporated directly into end products at any level of manufacture, fabrication, or assembly by the Contractor or any subcontractor.

(2) "Department of Defense (DoD)" means the Army, Navy, Air Force, Marine Corps, and defense agencies.

(3) "Foreign flag vessel" means any vessel that is not a U.S.-flag vessel.

(4) "Ocean transportation" means any transportation aboard a ship, vessel, boat, barge, or ferry through international waters.

(5) "Subcontractor" means a supplier, materialman, distributor, or vendor at any level below the prime Contractor whose contractual obligation to perform results from, or is conditioned upon, award of the prime contract and who is performing any part of the work or other requirement of the prime contract. However, effective May 1, 1996, the term does not include a supplier, materialman, distributor, or vendor of commercial items or commercial components.

(6) "Supplies" means all property, except land and interests in land, that is clearly identifiable for eventual use by or owned by the DoD at the time of transportation by sea.

(i) An item is clearly identifiable for eventual use by the DoD if, for example, the contract documentation contains a reference to a DoD contract number or a military destination.

(ii) Supplies includes (but is not limited to) public works; buildings and facilities; ships; floating equipment and vessels of every character, type, and description, with parts, subassemblies, accessories, and equipment; machine tools; material; equipment; stores of all kinds; end items; construction materials; and components of the foregoing.

(7) "U.S.-flag vessel" means a vessel of the United States or belonging to the United States, including any vessel registered or having national status under the laws of the United States.

(b) The Contractor shall employ U.S.-flag vessels in the transportation by sea of any supplies to be furnished in the performance of this contract. The Contractor and its subcontractors may request that the Contracting Officer authorize shipment in foreign-flag vessels, or designate available U.S.-flag vessels, if the Contractor or a subcontractor believes that--

(1) U.S.-flag vessels are not available for timely shipment;
(2) The freight charges are inordinately excessive or unreasonable; or
(3) Freight charges are higher than charges to private persons for transportation of like goods.

(c) The Contractor must submit any request for use of other than U.S.-flag vessels in writing to the Contracting Officer at least 45 days prior to the sailing date necessary to meet its delivery schedules. The Contracting Officer will process requests submitted after such date(s) as expeditiously as possible, but the Contracting Officer's failure to grant approvals to meet the shipper's sailing date will not of itself constitute a compensable delay under this or any other clause of this contract. Requests shall contain at a minimum--

(1) Type, weight, and cube of cargo;
(2) Required shipping date;
(3) Special handling and discharge requirements;
(4) Loading and discharge points;
(5) Name of shipper and consignee;
(6) Prime contract number; and
(7) A documented description of efforts made to secure U.S.-flag vessels, including points of contact (with names and telephone numbers) with at least two U.S.-flag carriers contacted. Copies of telephone notes, telegraphic and facsimile message or letters will be sufficient for this purpose.

(d) The Contractor shall, within 30 days after each shipment covered by this clause, provide the Contracting Officer and the Division of National Cargo, Office of Market Development, Maritime Administration, U.S. Department of Transportation, Washington, DC 20590, one copy of the rated on board vessel operating carrier's ocean bill of lading, which shall contain the following information--

(1) Prime contract number;
(2) Name of vessel;
(3) Vessel flag of registry;
(4) Date of loading;
(5) Port of loading;
(6) Port of final discharge;
(7) Description of commodity;
(8) Gross weight in pounds and cubic feet if available;
(9) Total ocean freight in U.S. dollars; and
(10) Name of the steamship company.

(e) The Contractor agrees to provide with its final invoice under this contract a representation that to the best of its knowledge and belief--

(1) No ocean transportation was used in the performance of this contract;
(2) Ocean transportation was used and only U.S.-flag vessels were used for all ocean shipments under the contract;
(3) Ocean transportation was used, and the Contractor had the written consent of the Contracting Officer for all non-U.S.-flag ocean transportation; or

(4) Ocean transportation was used and some or all of the shipments were made on non-U.S.-flag vessels without the written consent of the Contracting Officer. The Contractor shall describe these shipments in the following format:

	Item Description	Contract Line Items	Quantity
Total....			

(f) If the final invoice does not include the required representation, the Government will reject and return it to the Contractor as an improper invoice for the purposes of the Prompt Payment clause of this contract. In the event there has been unauthorized use of non-U.S.-flag vessels in the performance of this contract, the Contracting Officer is entitled to equitably adjust the contract, based on the unauthorized use.

(g) The Contractor shall include this clause, including this paragraph (g) in all subcontracts under this contract, which exceed the simplified acquisition threshold in Part 13 of the Federal Acquisition Regulation.

28. FAR 52.252-4 ALTERATIONS IN CONTRACT (APR 1984)

Portions of this contract are altered as follows: None

29. FAR 52.252-6 AUTHORIZED DEVIATIONS IN CLAUSES (APR 1984)

(a) The use in this solicitation or contract of any Federal Acquisition Regulation (48 CFR Chapter 1) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the clause.

(b) The use in this solicitation or contract of any Department of Defense FAR Supplement (48 CFR Chapter 2) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

30. DFARS 252.223-7004 DRUG-FREE WORK FORCE (SEP 1988)

(a) Definitions.

(1) "Employee in a sensitive position," as used in this clause, means an employee who has been granted access to classified information; or employees in other positions that the Contractor determines involve national security, health or safety, or functions other than the foregoing requiring a high degree of trust and confidence.

(2) "Illegal drugs," as used in this clause, means controlled substances included in Schedules I and II, as defined by section 802(6) of Title 21 of the United States Code, the possession of which is unlawful under Chapter 13 of that Title. The term "illegal drugs" does not mean the use of a controlled substance pursuant to a valid prescription or other uses authorized by law.

(b) The Contractor agrees to institute and maintain a program for achieving the objective of a drug-free work force. While this clause defines criteria for such a program, contractors are encouraged to implement alternative approaches comparable to the criteria in paragraph (c) that are designed to achieve the objectives of this clause.

(c) Contractor programs shall include the following, or appropriate alternatives:

(1) Employee assistance programs emphasizing high level direction, education, counseling, rehabilitation, and coordination with available community resources;

(2) Supervisory training to assist in identifying and addressing illegal drug use by Contractor employees;

(3) Provisions for self-referrals as well as supervisory referrals to treatment with maximum respect for individual confidentiality consistent with safety and security issues;

(4) Provision for identifying illegal drug users, including testing on a controlled and carefully monitored basis. Employee drug testing programs shall be established taking account of the following:

(i) The Contractor shall establish a program that provides for testing for the use of illegal drugs by employees in sensitive positions. The extent of and criteria for such testing shall be determined by the Contractor based on considerations that include the nature of the work being performed under the contract, the employee's duties, the efficient use of Contractor resources, and the risks to health, safety, or national security that could result from the failure of an employee adequately to discharge his or her position.

(ii) In addition, the Contractor may establish a program for employee drug testing--

(A) When there is a reasonable suspicion that an employee uses illegal drugs; or

(B) When an employee has been involved in an accident or unsafe practice;

(C) As part of or as a follow-up to counseling or rehabilitation for illegal drug use;

(D) As part of a voluntary employee drug testing program

(iii) The Contractor may establish a program to test applicants for employment for illegal drug use.

(iv) For the purpose of administering this clause, testing for illegal drugs may be limited to those substances for which testing is prescribed by section 2.1 of Subpart B of the "Mandatory Guidelines for Federal Workplace Drug Testing Programs" (53FR 11980 (April 11, 1988)), issued by the Department of Health and Human Services.

(d) Contractors shall adopt appropriate personnel procedures to deal with employees who are found to be using drugs illegally. Contractors shall not allow any employee to remain on duty or perform in a sensitive position who is found to use illegal drugs until such time as the Contractor, in accordance with procedures established by the Contractor, determines that the employee may perform in such a position.

(e) The provisions of this clause pertaining to drug testing programs shall not apply to the extent they are inconsistent with state or local law, or with an existing collective bargaining agreement; provided that with respect to the latter, the Contractor agrees that those issues that are in conflict will be a subject of negotiation at the next collective bargaining session.

31. EFARS 52.249-5000 BASIS FOR SETTLEMENT OF PROPOSALS (DEC 1995)

Actual costs will be used to determine equipment costs for a settlement proposal submitted on the total cost basis under FAR 49.206-2(b). In evaluating a termination settlement proposal using the total cost basis, the following principles will be applied to determine allowable equipment costs:

(1) Actual costs for each piece of equipment or groups of similar serial or series equipment need not be available in the Contractor's accounting records to determine total actual equipment costs.

(2) If equipment costs have been allocated to a contract using predetermined rates, those charges will be adjusted to actual costs.

(3) Recorded job costs adjusted for unallowable expenses will be used to determine equipment operating expenses.

(4) Ownership costs (depreciation) will be determined using the Contractor's depreciation schedule (subject to the provisions of FAR 31.205-11).

(5) License, taxes, storage and insurance costs are normally recovered as an indirect expense and unless the Contractor charges these costs directly to contracts, they will be recovered through the indirect expense rate.

32. AS-BUILT DRAWINGS (PROGRESS PAYMENT)

One-half of one percent of construction award money shall be withheld until the final as-built drawings and CADD files are accepted by the Government.

END OF SECTION

ATTACHMENTS

ATTACHMENTS

1. GENERAL WAGE DECISION

2. DD FORM 2051, APPLICATION FOR COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE - SEE SECTION 00100, DFARS 252.204-7001. COMPLETE SECTION B, BLOCKS 1 THROUGH 10, OF THE DD FORM 2051 AND RETURN WITH BID/COST PROPOSAL IF YOU DO NOT ALREADY HAVE A CAGE CODE.

   IF YOU HAVE BEEN AWARDED A DOD CONTRACT WITHIN THE PAST SEVERAL YEARS, THE OFFICE THAT MADE THE AWARD WILL PROBABLY HAVE YOUR CAGE CODE NUMBER IN THEIR DATA BASE. (SACRAMENTO DISTRICT WILL NOT HAVE INFORMATION ON LOS ANGELES DISTRICT AWARDS AND VICE VERSA.) IF YOU DO NOT KNOW YOUR CAGE CODE NUMBER, SUBMIT THE DD FORM 2051 WITH YOUR BID/PROPOSAL. PLEASE DO NOT SEND THE DD FORM 2051 AHEAD OF TIME. BE SURE THAT YOU USE A STREET ADDRESS FOR YOUR FIRM, NOT A POST OFFICE BOX.

   DO NOT UNDER ANY CIRCUMSTANCES DELAY SUBMITTING YOUR BID OR PROPOSAL WHILE ATTEMPTING TO OBTAIN A CAGE CODE NUMBER OR INFORMATION ON HOW TO COMPLETE THE DD FORM 2051. FAILURE TO FURNISH A CAGE CODE NUMBER OR THE FORM WILL NOT RENDER YOUR BID/PROPOSAL NONRESPONSIVE.

   IN ORDER TO FILL IN THE STANDARD INDUSTRIAL CLASSIFICATION (SIC) NUMBER AS REQUIRED BY THE DD FORM 2051, YOU WILL FIND THE SIC CODE FOR THIS SOLICITATION IN SECTION 00600, FAR 52.219-1. TO LIST OTHER SIC CODES YOUR FIRM IS ALSO IN THE BUSINESS TO PROVIDE, THE STANDARD INDUSTRIAL CLASSIFICATION MANUAL IS SOLD BY THE NATIONAL TECHNICAL INFORMATION SERVICE, 5285 PORT ROYAL ROAD, SPRINGFIELD, VIRGINIA 22161. THE ORDER NUMBER IS PB 87-100012.

3. PREAWARD SURVEY - SEE SECTION 00100, SAACONS 52.0209-4501. THE PREAWARD SURVEY IS ATTACHED FOR INFORMATION PURPOSES ONLY; IT WILL BE REQUIRED ONLY FROM THE LOW BIDDER AFTER BID OPENING IF THE LOW BIDDER HAS NOT HAD A CONTRACT WITH THE LOS ANGELES DISTRICT, CORPS OF ENGINEERS, IN THE LAST TWELVE-MONTH PERIOD. IT IS NOT REQUIRED AS PART OF THE BID PACKAGE.

4. SAMPLE SUBCONTRACTING PLAN - SEE SECTION 00100, SAACONS 52.0219-4581; SECTION 00800, FAR 52.219-9, AND SAACONS 52.0219-4509. THE SAMPLE SUBCONTRACTING PLAN IS ATTACHED FOR INFORMATION PURPOSES ONLY. A SUBCONTRACTING PLAN WILL BE REQUIRED ONLY FROM THE LOW BIDDER IF THE LOW BIDDER IS A LARGE BUSINESS AND THE LOW BID IS OVER $1 MILLION. A SUBCONTRACTING PLAN IS NOT REQUIRED FROM SMALL BUSINESSES. THE SUBCONTRACTING PLAN IS NOT REQUIRED FROM THE LOW BIDDER UNTIL AFTER THE BID OPENING; IT IS NOT REQUIRED AS PART OF THE BID PACKAGE.

General Decision Number CA980039

General Decision Number CA980039
Superseded General Decision No. CA970039
State: California
Construction Type:
BUILDING
DREDGING
HEAVY
HIGHWAY
County(ies):
SANTA BARBARA
BUILDING CONSTRUCTION PROJECTS; DREDGING PROJECTS (does not include hopper dredge work); HEAVY CONSTRUCTION PROJECTS (does not include water well drilling); HIGHWAY CONSTRUCTION PROJECTS

Modification Number	Publication Date
0	02/13/1998
1	03/06/1998
2	04/17/1998
3	07/10/1998
4	10/09/1998

COUNTY(ies):
SANTA BARBARA

* ASBE0005B 09/21/1997	Rates	Fringes
INSULATOR/ASBESTOS WORKER		
Includes the application of all insulating materials, protective coverings, coatings, and finishings to all types of mechanical systems	28.21	7.53

ASBE0208B 06/01/1996	Rates	Fringes
ASBESTOS REMOVAL WORKER/ HAZARDOUS MATERIAL HANDLER		
Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials from mechanical systems, whether they contain asbestos or not	19.70	4.81

* BOIL0092F 10/01/1998	Rates	Fringes
BOILERMAKER	28.81	9.81
TUBE WELDER	30.31	9.81

BRCA0004H 05/01/1997	Rates	Fringes
BRICKLAYER; MARBLE SETTER	22.72	6.53

BRCA0018I 08/01/1996	Rates	Fringes
TILE SETTERS	23.60	4.65

BRCA0018K 06/01/1996	Rates	Fringes
TERRAZZO WORKER	25.97	4.15
TERRAZZO FINISHER	20.16	4.15

CARP0002A 07/01/1997	Rates	Fringes
CARPENTERS:		
Carpenter (including drywall lathing), cabinet installer, floor worker and acoustical installer	23.80	5.18
Insulation installer:		
Wood frame or concrete block or tilt-up, Types III, IV and V construction	17.00	4.81
All other work	23.80	5.18
Shingler	23.93	5.18
Saw filer	23.88	5.18
Table power saw operator	23.90	5.18
Pneumatic nailer or power stapler	24.05	5.18

Commercial fence builder	20.80	5.18
Roof loader of shingles (commercial)	16.75	5.18
Millwright	24.30	5.18
Pile driver; Derrick barge; Bridge or dock carpenter; Cable splicer; Heavy framer; Rock slinger	23.93	5.18
Head rock slinger	24.03	5.18
Rock barge or scow	23.83	5.18

CARP0002B 07/01/1996

	Rates	Fringes
DIVERS:		
Diver, Wet	52.86	5.10
Diver, Stand-by	26.43	5.10
Diver Tender	25.43	5.10

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* ELEC0011L 01/01/1997

	Rates	Fringes
COMMUNICATIONS AND SYSTEMS WORK:		
COMMUNICATIONS & SYSTEMS:		
Installer	18.03	3% + 3.50
Technician	19.78	3% + 3.50

SCOPE OF WORK:

Installation, testing, service and maintenance of systems utilizing the transmission and/or transference of voice, sound, vision and digital for commercial, educational, security and entertainment purposes for the following: TV monitoring and surveillance, background-foreground music, intercom and telephone interconnect, microwave transmission, multi-media, multiplex, nurse call systems, radio page, burglar alarms and fire alarm (see last paragraph below).

Communication Systems that transmit or receive information and/or control systems that are intrinsic to the above listed systems; inclusion or exclusion of terminations and testings of conductors determined by their function; excluding all other data systems or multiple systems which include control function or power supply; excluding installation of raceway systems, conduit systems, line voltage work, and energy management systems.

Work performed at Point Arguello or Vandenberg Air Force Base to be performed by the electrician.

Fire alarm work shall be performed at the current inside wireman total cost package.

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* ELEC0413A 06/01/1998

	Rates	Fringes
ELECTRICIANS:		
VANDENBERG AIR FORCE BASE:		
Electrical subcontracts over $50,000:		
Electrician	30.87	3%+7.55
Electrician, welding	31.37	3%+7.55
Cable splicer	32.37	3%+7.55
Electrical subcontracts $50,000 or less:		
Electrician	27.10	3%+7.55

Electrician, welding	27.60	3%+7.55
Cable splicer	28.60	3%+7.55
REMAINDER OF COUNTY:		
Electrical subcontracts over $50,000:		
Electrician	27.12	3%+7.55
Electrician, welding	27.62	3%+7.55
Cable splicer	28.62	3%+7.55
Electrical subcontracts $50,000 or less:		
Electrician	23.35	3%+7.55
Electrician, welding	23.85	3%+7.55
Cable splicer	24.85	3%+7.55

ELEC1245A 06/01/1998

	Rates	Fringes
LINE CONSTRUCTION (includes outside utility transmission work):		
Line worker; Cable splicer	29.50	4.5%+6.78
Powder worker	28.03	4.5%+6.54
Ground person	19.18	4.5%+6.50
Line worker, welding	30.98	4.5%+7.02

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* ELEV0018A 09/15/1998

	Rates	Fringes
ELEVATOR MECHANIC	31.025	6.675

FOOTNOTE:
Vacation Pay: 8% with 5 or more years of service, 6% for 6 months to 5 years service. Paid Holidays: New Years Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Friday after, and Christmas Day.

ENGI0012C 07/01/1997

	Rates	Fringes
POWER EQUIPMENT OPERATORS:		
GROUP 1	24.30	9.95
GROUP 2	25.08	9.95
GROUP 3	25.37	9.95
GROUP 4	25.51	9.95
GROUP 5	26.61	9.95
GROUP 6	25.73	9.95
GROUP 7	25.84	9.95
GROUP 8	26.94	9.95
GROUP 9	25.96	9.95
GROUP 10	27.06	9.95
GROUP 11	26.13	9.95
GROUP 12	26.23	9.95
GROUP 13	26.26	9.95
GROUP 14	26.34	9.95
GROUP 15	26.46	9.95
GROUP 16	26.63	9.95
GROUP 17	26.73	9.95
GROUP 18	26.84	9.95
GROUP 19	26.96	9.95
GROUP 20	27.13	9.95
GROUP 21	27.23	9.95
GROUP 22	27.34	9.95

GROUP 23	27.46	9.95
GROUP 24	27.63	9.95
CRANES, PILEDRIVING & HOISTING EQUIPMENT:		
GROUP 1	24.30	9.95
GROUP 2	25.08	9.95
GROUP 3	25.37	9.95
GROUP 4	25.51	9.95
GROUP 5	25.73	9.95
GROUP 6	25.84	9.95
GROUP 7	25.96	9.95
GROUP 8	26.13	9.95
GROUP 9	26.30	9.95
GROUP 10	27.30	9.95
GROUP 11	28.30	9.95
GROUP 12	29.30	9.95
GROUP 13	30.30	9.95
TUNNEL WORK:		
GROUP 1	25.58	9.95
GROUP 2	25.87	9.95
GROUP 3	26.01	9.95
GROUP 4	26.23	9.95
GROUP 5	26.34	9.95
GROUP 6	26.46	9.95
GROUP 7	26.76	9.95

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Barge, brake, compressor operator, Ditch Witch, with seat or similar type equipment, elevator operator - inside, engineer oiler, generator operator, generator, pump or compressor plant operator, pump operator, signal, switch

GROUP 2: Concrete mixer operator - skip type, conveyor operator, fire person, hydrostatic pump operator, oiler crusher (asphalt or concrete plant), skiploader (when wheel type up to 3/4 yd. without attachment), tar pot fire person, temporary heating plant operator, trenching machine operator

GROUP 3: Equipment greaser (rack), Ford Ferguson (with dragtype attachments), helicopter radio (ground), power concrete curing machine operator, power concrete saw operator, power - driver jumbo form setter operator, stationary pipe wrapping and cleaning machine operator

GROUP 4: Asphalt plant fire person, backhoe operator (mini-max or similar type), boring machine operator, box or mixer (asphalt or concrete), chip spreading machine operator, concrete pump operator (small portable), drilling machine operator, small auger types (Texoma super economatic or similar types - Hughes 100 or 200 or similar types - drilling depth of 30' maximum), equipment greaser (grease truck), guard rail post driver operator, highline cableway signal, hydra-hammer-aero stomper, power sweeper operator, roller operator (compacting), screed operator (asphalt or concrete), trenching machine operator (up to 6 ft.)

GROUP 5: Equipment greaser (grease truck/multi-shift)

GROUP 6: Asphalt plant engineer, batch plant operator, bit sharpener, concrete joint machine operator (canal and similar type), concrete planer operator, deck engine operator, derrick (oilfield type), drilling machine operator, bucket or auger types (Caldwell 100 bucket or similar types - Watson 1000 auger or similar types - Texoma 330, 500 or 600 auger or similar types - drilling depth of 45' maximum), drilling machine operator,

hydrographic seeder machine operator (straw, pump or seed), Jackson track maintainer, or similar type, Kalamazoo switch tamper, or similar type, machine tool operator, Maginnis internal full slab vibrator, mechanical berm, curb or gutter (concrete or asphalt), mechanical finisher operator (concrete, Clary-Johnson-Bidwell or similar type), pavement breaker operator (truck mounted), road oil mixing machine operator, roller operator (asphalt or finish), rubber-tired earth moving equipment (single engine, up to and including 25 yds. struck), self-propelled tar pipelining machine operator, skiploader operator (crawler and wheel type, over 3/4 yd. and up to and including 1-1/2 yds.), slip form pump operator (power driven hydraulic lifting device for concrete forms), tractor operator - bulldozer, tamper-scraper (single engine, up to 100 h.p. flywheel and similar types, up to and including D-5 and similar types), tugger hoist operator

GROUP 7: Asphalt or concrete spreading operator (tamping or finishing), asphalt paving machine operator (Barber Greene or similar type), backhoe operator (up to and including 3/4 yd.), small Ford, Case or similar, cast-in-place pipe laying machine operator, combination mixer and compressor operator (gunite work), compactor operator (self-propelled), concrete mixer operator (paving), crushing plant operator, drill doctor, drilling machine operator, bucket or auger types (Caldwell 150 bucket or similar types - Watson 1500, 2000 2500 auger or similar types - Texoma 700, 800 auger or similar types - drilling depth of 60' maximum), elevating grader operator, grade checker, gradall operator, grouting machine operator, heavy-duty repair person, Kalamazoo ballast regulator or similar type, Kolman belt loader and similar type, Le Tourneau blob compactor or similar type, loader operator (Athey, Euclid, Sierra and similar types), pneumatic concrete placing machine operator (Hackley-Presswell or similar type), pumpcrete operator, rotary drill operator (excluding caisson type), rubber-tired earth-moving equipment operator (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. up to and including 50 cu. yds. struck), rubber-tired earth-moving equipment operator (multiple engine up to and including 25 yds. struck), rubber-tired scraper operator (self-loading paddle wheel type - John Deere, 1040 and similar single unit), self-propelled curb and gutter machine operator, skiploader operator (crawler and wheel type over 1-1/2 yds. up to and including 6-1/2 yds.), surface heater and planer operator, tractor compressor drill combination operator, tractor operator (any type larger than D-5 - 100 flywheel h.p. and over, or similar - bulldozer, tamper, scraper and push tractor single engine), tractor operator (boom attachments), traveling pipe wrapping, cleaning and bending machine operator, trenching machine operator

GROUP 8: Heavy-duty repair person (multi-shift)

GROUP 9: Drilling machine operator, bucket or auger types (Caldwell 200 B bucket or similar types - Watson 3000 or 5000 auger or similar types - Texoma 900 auger or similar types - drilling depth of 105' maximum), dual drum mixer, heavy-duty repair-welder combination, monorail locomotive operator (diesel, gas or electric), motor patrol - blade operator (single engine), multiple engine tractor operator (Euclid and similar type - except Quad 9 cat.), rubber-tired earth-moving equipment operator (single engine, over 50 yds. struck), rubber-tired earth-moving

equipment operator (multiple engine, Euclid, Caterpillar and similar over 25 yds. and up to 50 yds.), tower crane repair person, tractor loader operator (crawler and wheel type over 6-1/2 yds.), Woods mixer operator (and similar pugmill equipment)
GROUP 10: Heavy-duty repair-welder combination (multi-shift)
GROUP 11: Auto grader operator, automatic slip form operator, drilling machine operator, bucket or auger types (Caldwell, auger 200 CA or similar types - Watson auger 6000 or similar types - drilling depth of 175' maximum), hoe ram or similar with compressor, mass excavator operator, mechanical finishing machine operator, mobile form traveler operator, motor patrol operator (multi-engine), pipe mobile machine operator, rubber-tired earth-moving equipment operator (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck), rubber-tired self-loading scraper operator (paddle-wheel-auger type self-loading - two (2) or more units)
GROUP 12: Rubber-tired earth-moving equipment operator operating equipment with push-pull system (single engine, up to and including 25 yds. struck)
GROUP 13: Canal liner operator, canal trimmer operator, remote-control earth-moving equipment operator, wheel excavator operator
GROUP 14: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck), rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine - up to and including 25 yds. struck)
GROUP 15: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (single engine, over 50 yds. struck), rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)
GROUP 16: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 50 cu. yds. struck), tandem tractor operator (operating crawler type tractors in tandem - Quad 9 and similar type)
GROUP 17: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, up to and including 25 yds. struck)
GROUP 18: Concrete pump operator, truck-mounted, rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 cu. yds. struck), rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, up to and including 25 yds. struck)
GROUP 19: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, over 50 yds. struck)
GROUP 20: Rubber-tired earth-moving equipment operator,

operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)
GROUP 21: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, up to and including 25 yds. struck)
GROUP 22: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck), rubber-tired earth-moving equipment operator, operating with the tandem push-pull system (multiple engine, up to and including 25 yds. struck)
GROUP 23: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, over 50 yds. struck), rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)
GROUP 24: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)
CRANES, PILEDRIVING AND HOISTING EQUIPMENT CLASSIFICATIONS
GROUP 1: Engineer oiler; Fork lift operator (under 5 tons capacity)
GROUP 2: Truck crane oiler
GROUP 3: A-frame or winch truck operator; Ross carrier operator (jobsite)
GROUP 4: Bridge-type unloader and turntable operator; Helicopter hoist operator
GROUP 5: Stinger crane (Austin-Western or similar type); Tugger hoist operator (1 drum)
GROUP 6: Bridge crane operator; Cretor crane operator; Fork lift operator (over 5 tons); Hoist operator (Chicago boom and similar type); Lift mobile operator; Lift slab machine operator (Vagtborg and similar types); Material hoist operator; Shovel, backhoe, dragline, clamshell operator (over 3/4 yd. and up to 5 cu. yds. mrc); Tugger hoist operator
GROUP 7: Pedestal crane operator; Shovel, backhoe, dragline, clamshell operator (over 5 cu. yds. mrc); Tower crane repair; Tugger hoist operator (3 drum)
GROUP 8: Crane operator (up to and including 25 ton capacity); Crawler transporter operator; Derrick barge operator (up to and including 25 ton capacity); Hoist operator, stiff legs, Guy derrick or similar type (up to and including 25 ton capacity); Shovel, backhoe, dragline, clamshell operator (over 7 cu. yds. mrc)
GROUP 9: Crane operator (over 25 tons and up to and including 50 tons mrc); Derrick barge operator (over 25 tons up to and including 50 tons mrc); Highline cableway operator; Hoist operator, stiff legs, Guy derrick or similar type (over 25 tons up to and including 50 tons mrc); K-crane operator; Polar crane operator; Tower crane operator
GROUP 10: Crane operator (over 50 tons and up to and including 100 tons mrc); Derrick barge operator (over 50 tons up to and including 100 tons mrc); Hoist operator, stiff legs, Guy derrick

or similar type (over 50 tons up to and including 100 tons mrc)
GROUP 11: Crane operator (over 100 tons and up to and including 200 tons mrc); Derrick barge operator (over 100 tons up to and including 200 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 100 tons up to and including 200 tons mrc); Mobile tower crane operator (over 100 tons up to and including 200 tons mrc)
GROUP 12: Crane operator (over 200 tons up to and including 300 tons mrc); Derrick barge operator (over 200 tons up to and including 300 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 200 tons, up to and including 300 tons mrc); Mobile tower crane operator (over 200 tons, up to and including 300 tons mrc)
GROUP 13: Crane operator (over 300 tons); Derrick barge operator (over 300 tons); Helicopter pilot; Hoist operator, stiff legs, Guy derrick or similar type (over 300 tons); Mobile tower crane operator (over 300 tons)

TUNNEL CLASSIFICATIONS

GROUP 1: Skiploader (wheel type up to 3/4 yd. without attachment)
GROUP 2: Power-driven jumbo form setter operator
GROUP 3: Dinkey locomotive or motorperson (up to and including 10 tons)
GROUP 4: Bit sharpener; Equipment greaser (grease truck); Slip form pump operator (power-driven hydraulic lifting device for concrete forms); Tugger hoist operator (1 drum); Tunnel locomotive operator (over 10 and up to and including 30 tons)
GROUP 5: Backhoe operator (up to and including 3/4 yd.); Small Ford, Case or similar; Drill doctor; Grouting machine operator; Heading shield operator; Heavy-duty repairperson; Loader operator (Athey, Euclid, Sierra and similar types); Mucking machine operator (1/4 yd., rubber-tired, rail or track type); Pneumatic concrete placing machine operator (Hackley-Presswell or similar type); Pneumatic heading shield (tunnel); Pumpcrete gun operator; Tractor compressor drill combination operator; Tugger hoist operator (2 drum); Tunnel locomotive operator (over 30 tons)
GROUP 6: Heavy-duty repair/welder combination
GROUP 7: Tunnel mole boring machine operator

ENGI0012D 08/01/1997

	Rates	Fringes
POWER EQUIPMENT OPERATORS:		
DREDGING:		
HYDRAULIC SUCTION DREDGES:		
Lever Person Operator	29.15	9.95
Deckmate; Watch Engineer; Welder	26.07	9.95
Winch (stern winch on dredge)	25.52	9.95
Bargehand; Deckhand; Fire Person-Oiler; Leveehand	24.98	9.95
Dozer	26.18	9.95
CLAMSHELL DREDGES:		
Lever Person Operator	29.15	9.95
Watch Engineer; Deckmate	26.07	9.95
Barge Mate	25.59	9.95
Bargehand; Deckhand; Fire Person-Oiler	24.98	9.95

* IRON0001C 07/01/1998

	Rates	Fringes
IRONWORKERS:		
Fence erector	22.79	12.87
Ornamental, reinforcing and structural	23.68	12.87

FOOTNOTE:
Work at Vandenberg Air Force Base: $3.00 per hour additional.

LABO0001B 01/01/1998

	Rates	Fringes
BRICK TENDER:		
Subcontracts over $3 million	17.68	9.24
Subcontracts of $3 million or less	15.64	5.23

LABO0002H 07/01/1998

	Rates	Fringes
LABORERS:		
GROUP 1	17.83	9.39
GROUP 2	18.23	9.39
GROUP 3	18.43	9.39
GROUP 4	19.48	9.39
GROUP 5	19.68	9.39
TUNNEL LABORERS:		
GROUP 1	20.74	9.39
GROUP 2	20.86	9.39
GROUP 3	21.02	9.39
GROUP 4	21.30	9.39
GUNITE LABORERS:		
GROUP 1	20.86	11.02
GROUP 2	19.91	11.02
GROUP 3	16.40	11.02
HOUSEMOVERS (ONLY WHERE HOUSEMOVING IS INCIDENTAL TO A CONSTRUCTION CONTRACT):		
Housemover	15.50	8.38
Yard maintenance person	15.25	8.38

FOOTNOTE:
GUNITE PREMIUM PAY:
Workers working from a Bosn'n's Chair or suspended from a rope or cable shall receive 40 cents per hour above the foregoing applicable classification rates.
Workers doing gunite and/or shotcrete work in a tunnel shall receive 35 cents per hour above the foregoing applicable classification rates, paid on a portal-to-portal basis.
Any work performed on, in or above any smoke stack, silo, storage elevator or similar type of structure, when such structure is in excess of 75'-0" above base level and which work must be performed in whole or in part more than 75'-0" above base level, that work performed above the 75'-0" level shall be compensated for at 35 cents per hour above the applicable classification wage rate.

LABORER CLASSIFICATIONS

GROUP 1: Cleaning and handling of panel forms; Concrete screeding for rough strike-off; Concrete, water curing; Demolition laborer, the cleaning of brick if performed by a worker performing any other phase of demolition work, and the

cleaning of lumber; Fire watcher, limber, brush loader, piler and debris handler; Flag person; Gas, oil and/or water pipeline laborer; Laborer, asphalt-rubber material loader; Laborer, general or construction; Laborer, general clean-up; Laborer, landscaping; Laborer, jetting; Laborer, temporary water and air lines; Material hose operator (walls, slabs, floors and decks); Plugging, filling of shee bolt holes; Dry packing of concrete; Railroad maintenance, repair track person and road beds; Streetcar and railroad construction track laborers; Rigging and signaling; Scaler; Slip form raiser; Slurry seal crew (mixer operator, applicator operator, squeegee person, shuttle person, top person), filling of cracks by any method on any surface; Tar and mortar; Tool crib or tool house laborer; Traffic control by any method; Window cleaner; Wire mesh pulling - all concrete pouring operations

GROUP 2: Asbestos abatement; Asphalt shoveler; Cement dumper (on 1 yd. or larger mixer and handling bulk cement); Cesspool digger and installer; Chucktender; Chute handler, pouring concrete, the handling of the chute from readymix trucks, such as walls, slabs, decks, floors, foundation, footings, curbs, gutters and sidewalks; Concrete curer, impervious membrane and form oiler; Cutting torch operator (demolition); Fine grader, highways and street paving, airport, runways and similar type heavy construction; Gas, oil and/or water pipeline wrapper - pot tender and form person; Guinea chaser; Headerboard person - asphalt; Laborer, packing rod steel and pans; Membrane vapor barrier installer; Power broom sweeper (small); Riprap stonepaver, placing stone or wet sacked concrete; Roto scraper and tiller; Sandblaster (pot tender); Septic tank digger and installer (lead); Tank scaler and cleaner; Tree climber, faller, chain saw operator, Pittsburgh chipper and similar type brush shredder; Underground laborer, including caisson bellower

GROUP 3: Buggymobile person; Concrete cutting torch; Concrete pile cutter; Driller, jackhammer, 2-1/2 ft. drill steel or longer; Dri-pak-it machine; Gas, oil and/or water pipeline wrapper, 6-in. pipe and over, by any method, inside and out; High scaler (including drilling of same); Hydro seeder and similar type; Impact wrench multi-plate; Kettle person, pot person and workers applying asphalt, lay-kold, creosote, lime caustic and similar type materials ("applying" means applying, dipping, brushing or handling of such materials for pipe wrapping and waterproofing); Operator of pneumatic, gas, electric tools, vibrating machine, pavement breaker, air blasting, come-alongs, and similar mechanical tools not separately classified herein; Pipelayer's backup person, coating, grouting, making of joints, sealing, caulking, diapering and including rubber gasket joints, pointing and any and all other services; Rock slinger; Rotary scarifier or multiple head concrete chipping scarifier; Steel headerboard and guideline setter; Tamper, Barko, Wacker and similar type; Trenching machine, hand-propelled

GROUP 4: Asphalt raker, lute person, ironer, asphalt dump person, and asphalt spreader boxes (all types); Concrete core cutter (walls, floors or ceilings), grinder or sander; Concrete saw person, cutting walls or flat work, scoring old or new concrete; Cribber, shorer, lagging, sheeting and trench bracing, hand-guided lagging hammer; Head rock slinger; Laborer, asphalt-rubber distributor boot person; Laser beam in connection with

laborers' work; Oversize concrete vibrator operator, 70 lbs. and over; Pipelayer performing all services in the laying and installation of pipe from the point of receiving pipe in the ditch until completion of operation, including any and all forms of tubular material, whether pipe, metallic or non-metallic, conduit and any other stationary type of tubular device used for the conveying of any substance or element, whether water, sewage, solid gas, air, or other product whatsoever and without regard to the nature of material from which the tubular material is fabricated; No-joint pipe and stripping of same; Prefabricated manhole installer; Sandblaster (nozzle person), water blasting, Porta Shot-Blast; Welding in connection with laborers' work
GROUP 5: Blaster powder, all work of loading holes, placing and blasting of all powder and explosives of whatever type, regardless of method used for such loading and placing; Driller: All power drills, excluding jackhammer, whether core, diamond, wagon, track, multiple unit, and any and all other types of mechanical drills without regard to the form of motive power; Toxic waste removal

TUNNEL LABORER CLASSIFICATIONS

GROUP 1: Batch plant laborer; Bull gang mucker, track person; Changehouse person; Concrete crew, including rodder and spreader; Dump person; Dump person (outside); Swamper (brake person and switch person on tunnel work); Tunnel materials handling person
GROUP 2: Chucktender, cabletender; Loading and unloading agitator cars; Nipper; Pot tender, using mastic or other materials (for example, but not by way of limitation, shotcrete, etc.); Vibrator person, jack hammer, pneumatic tools (except driller)
GROUP 3: Blaster, driller, powder person; Chemical grout jet person; Cherry picker person; Grout gun person; Grout mixer person; Grout pump person; Jackleg miner; Jumbo person; Kemper and other pneumatic concrete placer operator; Miner, tunnel (hand or machine); Nozzle person; Operating of troweling and/or grouting machines; Powder person (primer house); Primer person; Sandblaster; Shotcrete person; Steel form raiser and setter; Timber person, retimber person, wood or steel; Tunnel Concrete finisher
GROUP 4: Diamond driller; Sandblaster; Shaft and raise work

GUNITE LABORER CLASSIFICATIONS

GROUP 1: Nozzle person and rod person
GROUP 2: Gun person
GROUP 3: Rebound person

LABO0402E 07/01/1996

	Rates	Fringes
PLASTERER TENDER:		
North part of county	17.34	8.88
South part of county	18.34	8.88

LABO0882A 01/01/1997

	Rates	Fringes
ASBESTOS REMOVAL LABORER	10.37	3.51

SCOPE OF WORK: includes site mobilization, initial site clean-up, site preparation, removal of asbestos-containing material and toxic waste (including lead abatement and any other toxic materials), encapsulation, enclosure and disposal of asbestos-

containing materials and toxic waste (including lead abatement and any other toxic materials) by hand or with equipment or machinery; scaffolding, fabrication of temporary wooden barriers, and assembly of decontamination stations.

LABO1184A 07/01/1998

	Rates	Fringes
LABORERS - STRIPING:		
GROUP 1	18.36	7.85
GROUP 2	18.76	7.85
GROUP 3	20.33	7.85
GROUP 4	21.33	7.85

LABORERS - STRIPING CLASSIFICATIONS

GROUP 1: Protective coating, pavement sealing, including repair and filling of cracks by any method on any surface in parking lots, game courts and playgrounds; carstops; operation of all related machinery and equipment

GROUP 2: Traffic surface abrasive blaster; pot tender - removal of all traffic lines and markings by any method (sandblasting, waterblasting, grinding, etc.) and preparation of surface for coatings. Traffic control person: controlling and directing traffic through both conventional and moving lane closures; operation of all related machinery and equipment

GROUP 3: Traffic delineating device applicator: Layout and application of pavement markers, delineating signs, rumble and traffic bars, adhesives, guide markers, other traffic delineating devices including traffic control. This category includes all traffic related surface preparation (sandblasting, waterblasting, grinding) as part of the application process. Traffic protective delineating system installer: removes, relocates, installs, permanently affixed roadside and parking delineation barricades, fencing, cable anchor, guard rail, reference signs, monument markers; operation of all related machinery and equipment; power broom sweepers

GROUP 4: Striper: layout and application of traffic stripes and markings; hot thermo plastic; tape traffic stripes and markings, including traffic control; operation of all related machinery and equipment

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* PAIN0036B 07/01/1998

	Rates	Fringes
PAINTERS (including lead abatement):		
Work on service stations and and car washes; Small new commercial work (defined as construction up to and including 3 stories in height, such as small shopping centers, small stores, small office buildings and small food establishments); Small new industrial work (defined as light metal buildings, small warehouses, small storage facilities and tilt-up buildings); Repaint		

work (defined as repaint of any structure with the exception of work involving the aerospace industry, breweries, commercial recreational facilities, hotels which operate commercial establishments as part of hotel service, and sports facilities); Tenant improvement work (defined as tenant improvement work not included in conjunction with the construction of the building, and all repainting of tenant improvement projects	17.20	5.56
All other work:		
All military bases:		
Iron & steel	21.69	5.56
High iron & steel (structural steel and components above 30 ft.)	22.69	5.56
Steeplejack	23.69	5.56
Remainder of county	21.49	5.56

PAIN0036H 07/01/1997

	Rates	Fringes
DRYWALL FINISHERS:		
Work on wood frame structures	18.00	3.34
All other work	24.06	5.52

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* PAIN0636B 06/01/1998

	Rates	Fringes
GLAZIER	25.05	7.23

FOOTNOTES:

Work in a condor, from the third (3rd) floor and up: $1.25 per hour additional.

Work on the outside of the building from a swing stage or any suspended contrivance, from the ground up: $1.25 per hour additional.

PAIN1247B 10/01/1997

	Rates	Fringes
SOFT FLOOR LAYER	24.10	6.07

PLAS0200A 08/06/1997

	Rates	Fringes
PLASTERERS	23.38	4.04

PLAS0500B 07/01/1998

	Rates	Fringes
CEMENT MASONS:		
Work on projects where the total permit value of the general and all subcontracts is $12 million or less:		

Cement Mason; Curb and Gutter
Machine; Clary and similar
type of Screed operator
(cement only); Grinder;
Jackson Vibratory, Texas
Screed and similar type
Screed operator; Scoring
Machine Operator 18.30 8.43
Cement Mason (Magnesite -
Epoxy) 18.42 8.43
Cement Mason, Floating and
Troweling Machine operator 18.55 8.43
ALL OTHER WORK:
Cement Mason; Curb and Gutter
Machine operator; Clary and
similar type of Screed
operator (cement only);
Grinding machine (all types);
Jackson Vibratory, Texas
Screed and similar type
Screed operator; Scoring
Machine operator 20.26 11.30
Cement Mason (Magnesite,
Magnesite - Terrazzo and
Mastic composition, Epoxy,
Urethanes and exotic
coatings, Dex-O-Tex) 20.38 11.30
Cement Mason - Floating and
Troweling Machine operator 20.51 11.30

PLUM0016D 07/01/1996

	Rates	Fringes
PLUMBERS; STEAMFITTERS:		
Vandenberg Air Force Base	30.56	7.54
Remainder of County	28.31	7.54

PLUM0345A 07/01/1998

	Rates	Fringes
LANDSCAPE & IRRIGATION FITTER	23.23	6.80

ROOF0036B 09/01/1996

	Rates	Fringes
ROOFERS:		
Roofer	21.77	6.385
Preparer (duties limited to the following: Roof removal of any type of roofing or roofing material; or spudding, or sweeping; and/or clean-up; and/or preload in, or in preparing the roof for application of roofing, damp and/or waterproofing material)	16.24	1.00

FOOTNOTE:
Pitch premium: Work on which employees are exposed to pitch fumes or required to handle pitch, pitch base or pitch impregnated products, or any material containing coal tar pitch,

the entire roofing crew shall receive $1.75 per hour "pitch premium" pay.

SFCA0669G 04/01/1998

	Rates	Fringes
SPRINKLER FITTER (FIRE)	26.85	6.35

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* SHEE0273B 08/01/1998

	Rates	Fringes
SHEET METAL WORKER	25.05	9.24

TEAM0011H 07/01/1998

	Rates	Fringes
TRUCK DRIVERS:		
Point Arguello; Point Conception; and Vandenberg Air Force Base:		
GROUP 1	21.79	11.89
GROUP 2	21.94	11.89
GROUP 3	22.07	11.89
GROUP 4	22.26	11.89
GROUP 5	22.20	11.89
GROUP 6	22.32	11.89
GROUP 7	22.57	11.89
GROUP 8	22.82	11.89
GROUP 9	23.02	11.89
GROUP 10	23.32	11.89
GROUP 11	23.82	11.89
Remainder of County:		
GROUP 1	19.79	11.89
GROUP 2	19.94	11.89
GROUP 3	20.07	11.89
GROUP 4	20.26	11.89
GROUP 5	20.20	11.89
GROUP 6	20.32	11.89
GROUP 7	20.57	11.89
GROUP 8	20.82	11.89
GROUP 9	21.02	11.89
GROUP 10	21.32	11.89
GROUP 11	21.82	11.89

TRUCK DRIVER CLASSIFICATIONS

GROUP 1: Truck driver

GROUP 2: Driver of vehicle or combination of vehicles - 2 axles; Traffic control pilot car excluding moving heavy equipment permit load; Truck-mounted broom

GROUP 3: Driver of vehicle or combination of vehicles - 3 axles; Boot person; Cement mason distribution truck; Fuel truck driver; Water truck - 2 axle; Dump truck, less than 16 yds. water level; Erosion control driver

GROUP 4: Driver of transit mix truck, under 3 yds.; Dumpcrete truck, less than 6-1/2 yds. water level

GROUP 5: Water truck, 3 or more axles; Truck greaser and tire person ($0.50 additional for tire person); Pipeline and utility working truck driver, including winch truck and plastic fusion, limited to pipeline and utility work; Slurry truck driver

GROUP 6: Transit mix truck, 3 yds. or more; Dumpcrete truck, 6-1/2 yds. water level and over; Vehicle or combination of vahicles - 4 or more axle; Oil spreader truck; Dump truck, 16

yds. to 25 yds. water level
GROUP 7: A Frame, Swedish crane or similar; Forklift driver; Ross carrier driver
GROUP 8: Dump truck, 25 yds. or more water level; Truck repair person; Water pull - single engine; Welder
GROUP 9: Truck repair person/welder; Low bed driver, 9 axles or over
GROUP 10: Dump truck - 50 yds. or more water level; Water pull - single engine with attachment
GROUP 11: Water pull - twin engine; Water pull - twin engine with attachments; Winch truck driver - $1.25 additional when operating winch or similar special attachments

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(v)).

In the listing above, the "SU" designation means that rates listed under that identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U. S. Department of Labor
200 Constitution Avenue, N. W.
Washington, D. C. 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N. W.

Washington, D. C. 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U. S. Department of Labor
200 Constitution Avenue, N. W.
Washington, D. C. 20210

4.) All decisions by the Administrative Review Board are final.

END OF GENERAL DECISION

REQUEST FOR ASSIGNMENT OF A COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE

(See Instructions on Reverse)

Form Approved
OMB No. 0704-0225
Expires Oct 31, 1991

Public reporting burden for this collection of information is estimated to average 7 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0225), Washington, DC 20503. Please DO NOT RETURN your form to either of these addresses. Send completed form to address on reverse.

SECTION A - TO BE COMPLETED BY INITIATOR

1. REQUESTING GOVERNMENT AGENCY/ACTIVITY

a. NAME: Activity Code: 369

b. ADDRESS (Street, City, State and Zip Code):
Corps of Engineers
1325 J Street, Room 878
Sacramento, CA 95814-2922

2. TYPE CODE REQUESTED (X one)	3. EXCEPTION CODES
a. TYPE A	a. CAO
b. TYPE F	b. ADP

4. INITIATOR

a. TYPED NAME (Last, First, Middle Initial)	b. OFFICE SYMBOL	c. SIGNATURE	d. TELEPHONE NO.
MILLER, RONALD J.	CESPK-CT		(916)557-5205

SECTION B - TO BE COMPLETED BY FIRM TO BE CODED

1. FIRM DO NOT USE A P.O. BOX ADDRESS!

a. NAME (Include Branch of, Division of, etc.)

b. ADDRESS (Street, City, State and Zip Code)

c. CAGE CODE (If previously assigned)

2. IF FIRM PREVIOUSLY OPERATED UNDER OTHER NAME(S) OR OTHER ADDRESS(ES) SPECIFY THE PREVIOUS NAME(S) AND/OR ADDRESS(ES) (Use separate sheet of paper, if necessary)

3. PARENT COMPANY AND AFFILIATED FIRMS (X one, and complete as applicable)

- a. NONE
- b. CURRENTLY AFFILIATED WITH OTHER FIRMS (List name(s) and address(es) of such firms on a separate sheet of paper)
- c. PREVIOUSLY AFFILIATED WITH OTHER FIRMS (List name(s) and address(es) of such firms on a separate sheet of paper)

4. PRIMARY BUSINESS CATEGORY (X one)

- a. MANUFACTURER
- b. DEALER/DISTRIBUTOR
- c. CONSTRUCTION FIRM
- d. SERVICE COMPANY
- e. SALES OFFICE
- f. OTHER (Specify)

5. DISADVANTAGED SMALL BUSINESS STATUS (X one)

- a. APPROVED BY SMALL BUSINESS ADMINISTRATION (SBA) FOR SECTION 8(a) PROGRAM
- b. OTHER DISADVANTAGED SMALL BUSINESS FIRM
- c. NOT DISADVANTAGED SMALL BUSINESS FIRM

6. NUMBER OF EMPLOYEES

7. WOMAN OWNED BUSINESS (X one): a. YES b. NO

8. STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE(S)

- a. PRIMARY
- b. OTHER (Specify)

9. REMARKS

SOLICITATION NUMBER: DACA 05 98-B-0049

CONTRACT SPECIALIST: LOS ANGELES PROJECT

10. FIRM OFFICIAL

a. TYPED NAME (Last, First, Middle Initial)	b. DATE SIGNED (YYMMDD)	c. SIGNATURE	d. TELEPHONE NO.
			/

INSTRUCTIONS FOR COMPLETING DD FORM 2051

GENERAL NOTE FOR PERSONNEL PREPARING OR PROCESSING THIS REPORT

Coding must be as indicated in the instructions. In cases where specific coding instructions are provided, reference must be made to the Department of Defense Manual for Standard Data Elements, DoD 5000.12-M. Noncompliance with either the coding instructions contained herein or those published in referenced manual will make the organization which fails to comply responsible for required concessions in data base communication.

SPECIFIC INSTRUCTIONS

SECTION A - TO BE COMPLETED BY THE INITIATING GOVERNMENT ACTIVITY

Item 1: Self-explanatory.

Item 2: Mark the type of code being requested.

a. Type A - Manufacturers Code which is used in the Federal Catalog System to identify a certain facility at a specific location which is a possible source for the manufacture and/or design control of items cataloged by the Federal Government; or,

b. Type F - Non-manufacturers Code which is required for identifying an organization/function in MILSCAP. These are assigned to contractors which are non-manufacturers or are manufacturers not qualifying for a Type A Code.

Item 3: If applicable, enter the exception DoD Activity Address Code for the Servicing Contract Administration Office (CAO) or ADP point.

Item 4: Self-explanatory.

SECTION B - TO BE COMPLETED BY THE FIRM TO WHICH THE CODE WILL BE ASSIGNED

Items 1a and 1b: Self-explanatory.

Item 1c: If a CAGE Code (Type A or Type F) was previously assigned, enter it in this block.

Item 2: Self-explanatory.

Item 3: If a block other than "None" is marked, identify the Parent company by a (P) beside the firm name.

SECTION B - *(Continued)*

Item 4: Self-explanatory.

Item 5: A disadvantaged business firm is defined as a firm that is 51%, or more, owned, controlled, and operated by a person(s) who is socially and economically disadvantaged. "Controlled" is defined as exercising the power to make policy decisions. "Operated" is defined as actively involved in the day-to-day management of the firm.

Item 6: Enter the number of employees. This number should include the employees of all affiliates.

Item 7: A woman-owned business is defined as a firm that is 51%, or more, owned, controlled, and operated by a woman or women. "Controlled" and "Operated" are as defined in Item 5.

Item 8: The SIC Code is a Government Index used to identify business activity and indicates the function (manufacturer, wholesaler, retailer, or service) and the line of business in which the company is engaged. If multiple SIC Codes, indicate the primary first, next important, etc.

Items 9 and 10: Self-explanatory.

NOTE: When any future changes are made to the coded facility; i.e., name change, location change, business sold or operations discontinued, etc., written notification stating the appropriate change should be sent to:

Commander
Defense Logistics Services Center
ATTN: DLSC-FBA
Federal Center
74 North Washington
Battle Creek, MI 49017-3084

PREAWARD SURVEY OF PROSPECTIVE CONTRACTORS
CONSTRUCTION CONTRACTS

It is the general policy of the Department of Defense that contracts shall be awarded only to contractors determined to be responsible in accordance with Part 9 of the Federal Acquisition Regulation (FAR).

No contract shall be awarded to any person or firm unless the Contracting Officer first makes an affirmative determination that the prospective contractor is responsible within the meaning of the FAR, Part 9.

Before making a determination of responsibility, the Contracting Officer shall have in his/her possession or obtain information sufficient to satisfy himself/herself that a prospective contractor currently meets the minimum FAR Part 9 standards.

In order to make the required determination and also to expedite the contract award, the following information must be submitted by the Contractor as directed (see Section 00100, SAACONS 52.0209-4501):

A. COMPLETED CONTRACTOR EXPERIENCE DATA FORM WITH SUPPLEMENTAL SCHEDULES A-D (ATTACHED).

B. LATEST FINANCIAL STATEMENTS. IF THE FINANCIAL STATEMENT IS MORE THAN 60 DAYS OLD, SUBMIT A CERTIFICATE STATING THAT THE FIRM’S FINANCIAL CONDITION IS SUBSTANTIALLY THE SAME, OR, IF NOT THE SAME, STATE THE CHANGES THAT HAVE TAKEN PLACE.

C. PROVIDE LETTERS FROM BANKS OR OTHER FINANCIAL INSTITUTIONS WITH WHICH THE CONTRACTOR CONDUCTS BUSINESS. THE LETTERS SHOULD CONTAIN INFORMATION ABOUT YOUR FIRM’S ACCOUNTS, LOANS, LINES OF CREDIT, ETC., PROVIDING INFORMATION LEADING TO A DETERMINATION THAT YOUR FIRM IS "RESPONSIBILE" AS DEFINED IN THE FEDERAL ACQUISITION REGULATION, PART 9, "HAS THE FINANCIAL RESOURCES TO PERFORM THE CONTRACT OR THE ABILITY TO OBTAIN THEM". THE GOVT IS INTERESTED IN FINANCIAL STABILITY, TIMELY PAYMENTS, THE LENGTH AND NATURE OF THE RELATIONSHIP BETWEEN THE FIRM AND THE FINANCIAL INSTITUTION, ETC. WHICH REVEALS THE FIRM’S FINANCIAL ABILITY TO PERFORM THE CONTRACT. THE LETTERS SHOULD ALSO PROVIDE THE NAME AND TELEPHONE NUMBER OF THE BANK REPRESENTATIVE THE GOVERNMENT MAY CONTACT.

BE SURE TO INCLUDE IN YOUR PREAWARD SURVEY, INFORMATION ON ANY CONTRACTS YOU HAVE HAD WITH THE SACRAMENTO DISTRICT OR LOS ANGELES DISTRICT, CORPS OF ENGINEERS, WITHIN THE LAST 12 MONTHS.

THESE DOCUMENTS SHALL BE TREATED BY THE GOVERNMENT AS CONFIDENTIAL.

CONSTRUCTION CONTRACTOR EXPERIENCE DATA

DATE (Day, Month, Year)

1. FIRM NAME

2. MAIN OFFICE ADDRESS (Street, City, State and Telephone)

3. BRANCH OFFICES

4. SERVICES RENDERED
☐ CONSTRUCTION
☐ DESIGN ☐ CONSULTANT

5. ORGANIZATION
☐ INDIVIDUAL ☐ JOINT VENTURE
☐ PARTNERSHIP ☐ CORPORATION

6. DATE ORGANIZED

7. DATE INCORPORATED AND STATE

8. NAMES OF OFFICERS AND OTHER KEY PERSONNEL

I – PRESENT PAYROLL PERSONNEL (List Number of Each Category Below)

PARTNERS	OFFICERS	OTHER KEY	REMAINDER	TOTAL	SUBTOTAL PERMANENT	MAXIMUM PERSONNEL AT ANY TIME
						DATE _____

II – EQUIPMENT OWNED

PRESENT VALUE ($)	ACQUISITION COST ($)

III – FINANCIAL DATA AS OF (Date) _____

CURRENT ASSETS	CURRENT LIABILITIES	NET WORTH

IV – TOTAL CONTRACT VALUE OF CONSTRUCTION AND DEMOLITION IN PAST SIX YEARS EXCLUSIVE OF JOINT VENTURE

19	$
19	$
19	$
19	$
19	$
19	$
AVERAGE ANNUAL $ INCOME	

LARGEST JOB IN PAST SIX YEARS

CONTRACT AMOUNT	DATE

DESCRIPTION

OWNER

V – LARGEST JOB EVER CONTRACTED (If Other Than In Past Six Years)

CONTRACT AMOUNT	DATE

DESCRIPTION

OWNER

VI – TYPE OF WORK IN WHICH FIRM SPECIALIZES

VII – TYPE OF WORK AND ACCEPTABLE LOCATIONS FOR WHICH FIRM DESIRES TO BE CONSIDERED

VIII – COST-REIMBURSEMENT TYPE CONTRACTS

AGENCY OR OWNER	DATE	DESCRIPTION	AMOUNT

TYPED NAME AND POSITION OR TITLE OF PERSON SIGNING

SIGNATURE

NOTE: Use reverse side for remarks, explanations, or detailed description of items reported above.

SCHEDULE A

CONSTRUCTION CONTRACTOR EXPERIENCE DATA

EXISTING COMMITMENTS: (List below the construction projects your firm has under way on this date, including those on which you are presently low bidder but have not received an award.)

CONTRACT NUMBER AND AMOUNT	DESCRIPTION OF WORK	FOR WHOM PERFORMED*	PERCENT COMPLETE	PERCENT SUBLET

* PROVIDE NAME OF ORGANIZATION, POINT OF CONTACT AND TELEPHONE NUMBER FOR CONTACT.

SCHEDULE B

CONSTRUCTION CONTRACTOR EXPERIENCE DATA

EXPERIENCE DATA: (List below the principal construction projects your firm has completed within the past six (6) years.)

CONTRACT NO.	AMOUNT	DESCRIPTION/LOCATION	CONTACT PERSON/PHONE NO	PERCENT SUBLET

SCHEDULE C

CONSTRUCTION CONTRACTOR EXPERIENCE DATA

CONSTRUCTION AND/OR TECHNICAL EQUIPMENT: (List total equipment and facilities owned for performing the work and present status as to whether or not it is committed to existing contracts.)

QUANTITY	DESCRIPTION	CONDITION	YEARS OF SERVICE	PRESENT STATUS

SCHEDULE D

CONSTRUCTION CONTRACTOR EXPERIENCE DATA

TO BE COMPLETED IF PROPOSED MILITARY CONSTRUCTION CONTRACT EXCEEDS $1,000,000.

A. Each contract awarded within the preceding three-month period exceeding $1,000,000 in value with brief description of the contract:

B. Each contract awarded within the preceding three-year period not already physically completed and exceeding $5,000,000 in value with brief description of the contract:

- S A M P L E -

SUBCONTRACTING PLAN

SUBCONTRACTING PLAN SUBMITTED IN ACCORDANCE WITH PUBLIC LAW 95-507 (THE FOLLOWING FORMAT IS ESTABLISHED IN ACCORDANCE WITH FAR 52.219-9(d)(1) THROUGH (d)(11) AND INCLUDES THE REQUIRED STATUTORY ELEMENTS AS DESCRIBED IN FAR 19.704. IT ALSO INCLUDES ADDITIONAL REQUIREMENTS OF THE DFARS 219.704 AND AFARS 219.704. EVALUATION OF THE SUBCONTRACTING PLAN BY THE GOVERNMENT WILL BE AS PRESCRIBED IN FAR (AND ITS SUPPLEMENTS) 19.705.

DO NOT JUST ADDRESS THE FOLLOWING ISSUES IN SHORT; FOLLOW THE GUIDANCE OF FAR 52.219-9 IN ITS ENTIRETY. FOR EXAMPLE, PARAGRAPH 11 BELOW ASKS FOR A DISCUSSION OF RECORDS; THE PLAN SHOULD ADDRESS ALL RECORDS AS DESCRIBED IN FAR 52.219-9(d)(11)(i) THROUGH (vi).

IN ACCORDANCE WITH FAR 19.704 IF THE CONTRACT CONTAINS OPTIONS, THE CUMULATIVE VALUE OF THE BASIC CONTRACT AND ALL OPTIONS IS CONSIDERED IN DETERMINING WHETHER A SUBCONTRACTING PLAN IS NECESSARY. ONCE IT HAS BEEN DECIDED IF A PLAN IS NECESSARY, THE SUBCONTRACTING PLAN SHALL CONTAIN SEPARATE PARTS, ONE FOR THE BASIC CONTRACT AND ONE FOR EACH OPTION. *IN OTHER WORDS, IT IS NECESSARY TO ADDRESS PLANNED SUBCONTRACTING DOLLARS AND PERCENTAGES OF TOTAL TO BE AWARDED TO SMALL; SMALL, DISADVANTAGED; WOMEN-OWNED SMALL; HBCU/MIs; AND QUALIFIED NONPROFIT AGENCIES FOR THE BLIND AND OTHER SEVERELY DISABLED SEPARATELY FOR THE BASIC CONTRACT PERIOD AND EACH OPTION YEAR. THEREFORE, PARAGRAPHS 1 AND 2 BELOW MUST BE PREPARED SEPARATELY FOR THE BASE YEAR AND EACH OPTION YEAR. ALL OTHER PARTS OF THE SUBCONTRACTING PLAN ONLY NEED TO BE ADDRESSED ONCE.*

A SMALL DISADVANTAGED BUSINESS GOAL OF LESS THAN FIVE PERCENT MUST BE APPROVED TWO LEVELS ABOVE THE CONTRACTING OFFICER (DFARS 219.705-4).

PROJECT TITLE: _____

RFP/IFB NO.: _____ CONTRACT NO.: _____

CONTRACTOR NAME: _____

DIVISION: _____

INDIVIDUAL COMPLETING THIS PLAN: _____

TELEPHONE NO.: _____

1. Goals, expressed in terms of percentages of total planned subcontracting dollars, for the use of small business concerns; small, disadvantaged business concerns; women-owned small business concerns; historically black colleges and universities (HBCUs) and minority institutions (MIs); and qualified nonprofit agencies for the blind and other severely disabled as subcontractors. The offeror shall include all subcontracts that contribute to contract performance and may include a proportionate share of products and services that are normally allocated as indirect costs.

Percentage Goals:

Small Business _____%

Small, Disadvantaged Business _____%

Women-Owned Small Business	_____%
HBCUs and MIs	_____%
Qualified Nonprofit Agencies for the Blind and Other Severely Disabled	_____%

2. Statement of: (i) total dollars planned to be subcontracted, (ii) total dollars planned to be subcontracted to small business; (iii) total dollars planned to be subcontracted to small, disadvantaged business; (iv) total dollars planned to be subcontracted to women-owned small business; (v) total dollars planned to be subcontracted to HBCUs and MIs; and (vi) total dollars planned to be subcontracted to qualified nonprofit agencies for the blind and other severely disabled.

Total Cost of Prime Contract:	$_____	
Total Dollars to be Subcontracted	$_____	_____%*
To Small Business	$_____	_____%**
To Small, Disadvantaged Business	$_____	_____%**
To Women-Owned Small Business	$_____	_____%**
To HBCUs and MIs	$_____	_____%**
To Qualified Nonprofit Agencies for the Blind and Other Severely Disabled	$_____	_____%**

NOTES: * Calculate percentage of Total Dollars to be Subcontracted to Total Cost of Prime Contract

** Calculate subcontracted dollars to each group to Total Dollars to be Subcontracted, NOT TO Total Cost of Prime Contract.

PLANNED SUBCONTRACTING INCLUDES ALL PLANNED EXPENDITURES. TOTAL ESTIMATED COST TO SUBCONTRACTORS AND GOALS MUST BE ESTABLISHED EVEN IF THE CONTRACT IS OF THE INDEFINITE-DELIVERY TYPE.

SUBCONTRACTS AWARDED TO SMALL, DISADVANTAGED BUSINESSES; WOMEN-OWNED SMALL BUSINESSES; HBCU/MIs; AND QUALIFIED NONPROFIT AGENCIES FOR THE BLIND AND OTHER SEVERELY DISABLED COUNT TOWARD THE OVERALL SMALL BUSINESS GOAL. HBCU/MIs ARE COUNTED AS A SUBSET OF THE SMALL, DISADVANTAGED GOAL. THE CORPS OF ENGINEERS HAS NOT BEEN ASSIGNED A SET GOAL FOR HBCU/MIs OR QUALIFIED NONPROFIT AGENCIES FOR THE BLIND AND OTHER SEVERELY DISABLED.

IN ACCORDANCE WITH DFARS 219.703, QUALIFIED NONPROFIT AGENCIES FOR THE BLIND AND OTHER SEVERELY DISABLED THAT HAVE BEEN APPROVED BY THE COMMITTEE FOR PURCHASE FROM PEOPLE WHO ARE BLIND OR SEVERELY DISABLED UNDER THE JAVITS-WARNER-O'DAY (41 U.S.C. 46-48) ARE ELIGIBLE THROUGH SEPTEMBER 30, 1997, TO PARTICIPATE IN THE PROGRAM.

3. A description of the principal supply and service areas to be subcontracted and an identification of the types planned for subcontracting to (i) small business subcontractors, (ii) small, disadvantaged business subcontractors, (iii) women-owned small business subcontractors, (iv) HBCUs and MIs, (v) qualified nonprofit agencies for the blind and other severely disabled:

4. A statement of the method used in developing the proposed subcontracting goals for small business concerns; small, disadvantaged business concerns; women-owned small business concerns; HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled:

5. Description of the method used to identify potential sources for solicitation purposes to assure small; small, disadvantaged, women-owned small; HBCU and MI; and qualified nonprofit agencies for the blind and other severely disabled participation (e.g., existing company source lists, the Procurement Automated Source System (PASS) of the Small Business Administration, the National Minority Purchasing Council Vendor Information Service, the Research and Information Division of the Minority Business Development Agency in the Department of Commerce, or small; small, disadvantaged, women-owned small, HBCU or MI, or qualified nonprofit agencies for the blind and other severely disabled concerns trade associations):

6. A statement as to whether or not the offeror included indirect costs in establishing the subcontracting goals, and if so, a description of the method used to determine the proportionate share of indirect costs to be incurred with: (i) small business concerns; (ii) small, disadvantaged business concerns; (iii) women-owned small business concerns; (iv) HBCUs and MIs); and (v) qualified nonprofit agencies for the blind and other severely disabled:

7. The name of the individual employed by the offeror who will administer the offeror's subcontracting program and a description of the duties of the individual.

Name: _____

Title and Telephone Number: _____

Address: _____

City, State and Zip Code: _____

Duties (Attachment may be used):

8. Describe the efforts the offeror will make to assure that small business concerns; small, disadvantaged business concerns; women-owned small business concerns; HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled will have an equitable opportunity to complete for subcontractors under this contract:

9. I do herewith assure that this concern will include the clause at FAR 52.219-8 entitled "Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns" in all subcontracts which offer further subcontracting opportunities and will require all subcontractors (except small business concerns) who receive subcontracts in excess of $500,000 (or, in the case of a contract for construction of any public facility, $1 million) to adopt a plan similar to the plan agreed to by this concern and in consonance with the FAR clause 52.219-9.

10. I also assure that this concern will (i) cooperate in any studies or surveys as may be required, (ii) submit periodic reports in order to allow the Government to determine the extent of compliance by the offeror with the subcontracting plan, and (iii) submit Standard Form (SF) 294, Subcontracting Report for Individual Contracts, and SF 295, Summary Subcontract Report, in accordance with the instructions of the forms, and (iv) ensure that the subcontractors under this contract agree to submit the required SF 294s and 295s. I assure that this concern will submit an SF 295 on Corps of Engineers

projects only. The SF 295 shall be completed and distributed in accordance with the Corps of Engineers supplemental instructions. I will not report Corps of Engineers projects through any other agency unless authorized by the Contracting Officer.

11. Provide a recitation of the types of records the offeror will maintain to demonstrate procedures which have been adopted to comply with the requirements and goals set forth in the plan, including the establishment of source lists; and a description of its efforts to locate small business concerns; small, disadvantaged business concerns; women-owned small business concerns; HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled and award subcontracts to them. The records shall include at least the following (on a plant-wide or company-wide basis, unless otherwise indicated):

a. Source lists (e.g., PASS), guides, and other data that identify small business concerns; small, disadvantaged business concerns; women-owned small business concerns; HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled.

b. Organizations contacted in an attempt to locate sources that are small; small disadvantaged; women-owned small business concerns, HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled.

c. Records on each subcontract solicitation resulting in an award of more than $100,000, indicating (A) whether small business concerns were solicited and if not, why not, (B) whether small disadvantaged business concerns were solicited and if not, why not, (C) whether women-owned small business concerns were solicited and if not, why not, (D) whether HBCUs and MIs were solicited and if not, why not, (E) whether qualified nonprofit agencies for the blind and other severely disabled were solicited and if not, why not, and (F) if applicable, the reason award was not made to a small business concern.

d. Records of any outreach efforts to contact (A) trade associations, (B) business development organizations, and (C) conferences and trade fairs to locate small; small disadvantaged; women-owned small business sources; HBCUs and MIs; and qualified nonprofit agencies for the blind and other severely disabled.

e. Records of internal guidance and encouragement provided to buyers through (A) workshops, seminars, training, etc., and (B) monitoring performance to evaluate compliance with the programs's requirements.

f. On a contract-by-contract basis, records to support award data submitted by the offeror to the Government, including the name, address, and business size of each subcontractor. Contractors having company or division-wide annual plans need not comply with this requirement.

12. Discuss the extent to which the offeror has historically been successful in complying with the requirements of the clauses at FAR 52.219-8, Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns, and 52.219-9, Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan, in establishing realistic yet challenging goals and show evidence of ability to achieve the goals. Information addressing past performance on DoD contracts evidencing achievement of established subcontracting goals will be in the form of Standard Forms 294 and 295 (attach these to this plan). Offerors who have had no prior Department of Defense contracts from which to assess past performance will not be penalized. Those who have had prior DoD contracts must provide the SF 294s and 295s on past DoD contracts.

_____
(Signature)

_____
(Title of Corporate Officer)

COMPLIANCE STATEMENT

SOLICITATION NUMBER: _____

PROJECT TITLE: _____

_____

PROJECT LOCATION: _____

NOTE:

In the event of a conflict after award between the Government specifications and the technical proposal, the specifications shall govern unless the exception or deviation is listed below and the exception/deviation is accepted by the Government. If accepted by the Government, this compliance statement identifying the agreement between the Government and the contractor shall be incorporated into the resultant contract and shall constitute a binding agreement between the Government and the contractor.

CERTIFICATION:

I hereby certify that the proposal submitted in response to subject solicitation complies fully with the specifications and drawings with the exception of the following differences, deviations, or exceptions:

Solicitation Reference	Explanation of Exceptions

IF NO DIFFERENCES, DEVIATIONS, OR EXCEPTIONS, SO STATE:

_____

SIGNATURE: _____

FIRM: _____

DATE: _____

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SECTION 01090

SOURCES FOR REFERENCE PUBLICATIONS

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-01) by the lack of a dash mark (-) in the sponsoring organization assigned number.

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.

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Fax: 703-222-2410

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Internet: www.diprn.org

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DEMOLITION

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)

EM 385-1-1	(1992) U.S. Army Corps of Engineers Safety and Health Requirements Manual

1.2 GENERAL REQUIREMENTS

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; salvaged items and materials shall be disposed of as specified.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Work Plan; FIO.

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.

1.4 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to

avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

1.5 PROTECTION

1.5.1 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.

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, may be allowed to remain standing without additional bracing, shoring, of lateral support until demolished. 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.

1.5.2 Protection of Existing Property

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.

1.5.3 Protection From the Weather

The interior of buildings to remain and salvageable materials and equipment shall be protected from the weather at all times.

1.5.4 Protection of 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 1.83 m (6 foot) high fence. The fence shall be securely erected a minimum of 1.5 m 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.

1.5.5 Environmental Protection

The work shall comply with the requirements of Section 01410.

1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.7 USE OF EXPLOSIVES

Use of explosives will be permitted.

1.8 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available after the IQT Facility is complete and accepted.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXISTING STRUCTURES

Existing structures indicated shall be removed to grade. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

3.2 UTILITIES

Disconnection of utility services, with related meters and equipment, are specified in Section 02685. Existing utilities shall be removed as indicated. 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.

3.3 FILLING

Holes and other hazardous openings shall be filled in accordance with Section 02221.

3.4 DISPOSITION OF MATERIAL

Title to material and equipment to be demolished, except Government salvage items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Salvageable Items and Material

Contractor shall salvage items and material to the maximum extent possible.

3.4.1.1 Material Salvaged for the Contractor

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.

3.4.1.2 Items Salvaged for the Government

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 by the Contracting Officer.

3.4.2 Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of as indicated by the Contracting Officer.

3.5 CLEAN UP

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 --

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SECTION 01330

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SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL IDENTIFICATION

SD-01 Data

SD-04 Drawings

SD-06 Instructions

SD-07 Schedules

SD-08 Statements

SD-09 Reports

SD-13 Certificates

SD-14 Samples

SD-18 Records

SD-19 Operation and Maintenance Manuals

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."

All submittals shall be reviewed and approved by the Contractor. However, certain designated submittals will also require acceptance by the Contracting Officer. These Government Acceptance (hereinafter as GA) submittals are required when the submittals:

(A) are not the subject of material, equipment, or technical construction methodologies, but relate primarily to management aspects of the construction contract provisions or activities, including, for example, such items as safety plans, contractor quality control plans, and environmental pollution control proposals, etc.

(B) are specifically indicated for Government acceptance in the final Submittal Register (ENG Form 4288) submitted by the Contractor and, therefore, the Government approval requirements in the final submittal register override any mention Government submittal approval requirements in various technical specifications sections.

(C) depict deviation from the contract (eg., an “or equal” decision, etc.).

(D) involve compatibility to existing equipment to provide an operational system or are an extension or design.

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 SUBMITTAL REVIEW AND APPROVAL

Before submission, Contractor shall review all submittals prepared by subcontractors, suppliers, and himself, for completeness, accuracy, and compliance with plans and specifications. Contractor shall not use red markings on submittals. Red markings are reserved for use by the Contracting Officer. The Contractor shall have an independent review agent, not associated with his organization, do the review of all submittals. The review by the independent agency shall be done by licensed architects or registered engineers in the appropriate disciplines of architectural, civil, structural, fire protection, mechanical, and electrical, as appropriate. The reviews shall be thorough and complete and authenticated by registered engineers's or architects's stamp. Contractor approval of submittals submitted to the Government by the Contractor, subcontractor, or any lower tier subcontractor, shall be indicated by an "Approved" stamp on the submittal with the Contractor's name, signature, and date, as shown at the end of this Section. This administration of submittal review must be integrated into the Contractor's Quality Control Plan. The requirement for independent agency review cannot be delegated to subcontractors or suppliers. The plan must delineate in precise detail how the Contractor intends to satisfy this requirement. This should include names of organizations, and individuals who will be doing the work with their qualifications/resumes. Supplier's or subcontractors certifications are not acceptable as meeting this requirement of independent review. Submittals not conforming to the requirements of this section will be returned to the Contractor for correction and resubmittal.

All submittals to the Government, Government Approved or Information Only, shall be submitted without any outstanding comments from the Contractor and/or Independent Reviewer; in other words, all comments by the Contractor and/or Independent Reviewer on all submittals shall be corrected before submission to the Government as Government Approved or Information Only.

1.4 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 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 resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.5 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.

1.6 PAYMENT FOR ITEMS FOR WHICH A SUBMITTAL AND APPROVAL IS REQUIRED

In accordance with FAR 52.232-5, "Payments Under Fixed-Price Construction Contracts", the Government shall make progress payments to the Contractor monthly based on estimates of work accomplished which meets the standards of quality established under the contract. On items for which submittals must be approved by the Contracting Officer, payment cannot be made for the item until the Government establishes that the item "meets the standards of quality" required by the contract. The Contractor shall not invoice for, nor shall the Government make payment for any item, for which submittal and approval is required, until the item has been submitted and approved as described herein.

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) representative and each item shall be stamped, signed, and dated by the CQC representative 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.

Submittals of all architectural finishes shall all be submitted at the same time so that they may be evaluated as a whole in comparison with the specified coordinated finishes. See Paragraph COLOR BOARDS for additional requirements of submittals.

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. Columns "d" through "q" have been completed by the Government; the Contractor shall complete columns "a" and "r" through "t" and submit the forms to the Contracting Officer for approval within thirty (30) calendar days after Notice to Proceed. 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.

3.3 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 35 calendar days exclusive of mailing time) shall be allowed and shown on the register for Government review and approval. No delay damages or time extensions will be allowed for time lost in late submittals.

3.4 TRANSMITTAL FORM (ENG Form 4025)

The Contractor shall complete ENG Form 4025, "Transmittal of Shop Drawings, Equipment Data, Material Samples, or Manufacturer's Certificates of Compliance" and forward four (4) copies of same with each set of shop drawings, certificates of compliance, materials, fixtures and equipment lists submitted for approval. Three (3) copies of the ENG Form 4025 shall be submitted for information only data. No translucent or coated reproduced copies will be accepted. Each item submitted shall be listed separately on the ENG Form 4025. For new submittals or resubmittals mark the appropriate box; or resubmittals also insert previous transmittal number. Blank ENG Forms 4025 will be furnished by the Contracting Officer on request. Shop drawings shall be either blue line or black line prints on a white background. Blueprints are not acceptable. Each submittal shall be identified with the Contractor's name, Contract Number, Transmittal Number, and Item Number to correspond with Item Number listed on ENG Form 4288. The following identification shall be marked on submittals as applicable:

Contract Number
Project Title and Location
Subcontractor's Name
Supplier's Name or Manufacturer's Name
Specification Section and Paragraph Number
Contract Drawing File Number

3.5 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.5.1 Procedures

Submittals required by the CONTRACT CLAUSES and other non-technical parts of the contract are not included in this section. The Contractor shall submit to the Contracting Officer: four (4) copies for approval, and three (3) copies for information only, of all shop drawings, certificates of compliance, materials, fixtures and equipment lists called for under the various headings of these specifications. These drawings, certificates and lists shall be complete and detailed and, prior to submission, must be reviewed and certified correct by the Contractor as required by the Quality Control System paragraph of the Construction Quality Control Section. If approved by the Contracting Officer, three (3) sets of all submittals will be retained by the Contracting Officer and one (1) set will be returned to the Contractor. Submittals for information only usually will not be returned. The Contractor is encouraged to submit paper documents that are printed/copied double-sided on recycled paper that has at least 20% postconsumer material.

(a) Resubmittals:

(1) If a submittal is returned for correction or is not satisfactory and is disapproved by the Contracting Officer, the Contractor shall resubmit the corrected material in the same quantity, including reproducibles as specified for the original submittal for approval within 14 days after receipt by him of the disapproved material.

3.5.2 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.

3.6 MECHANICAL ROOM LAYOUT DRAWINGS:

The Contractor shall submit a layout drawing, including appropriate elevations and sections as required, for each Mechanical Room showing the room arrangement he proposes for all pieces of equipment and appurtenances thereto (viz., air-conditioning equipment, boilers, compressors, hot water tanks, pumps, electrical control panels, ducts, piping, etc.), that are to be located in the room. The Mechanical Room floor slab will not be placed until the complete Mechanical Room layout drawing has been submitted and approved. No payment will be made to the Contractor for any of the equipment for the room or its installation until these drawings have been approved. Mechanical Room Layout Drawings shall be identified and submitted in the manner specified for "Shop Drawings". Equipment rooms shown on the drawings are of adequate size to accommodate equipment of required capacities, as available from several manufacturers, with sufficient space left for access, servicing, removal, etc. The use of equipment items with dimensions such as to crowd the space will not be permitted.

3.7 COLOR BOARDS

Five sets of color boards shall be submitted within 90 calendar days after receipt of Notice to Proceed for all projects which involve building

construction or building modifications. The board shall include samples of colors and finishes of all interior surfaces such as walls, floors, and ceilings. Material shall be submitted in a standard 8-1/2 inches by 11 inches three-ring binder. Fold-outs may be employed to 25-1/2 inches by 33 inches as long as they refold within the standard binder. Actual material samples shall be displayed showing color, texture, pattern, finish, thickness, etc., for all appearance related items where choice exists. These samples shall be large enough to indicate true patterns. However, care should be taken to present materials in proportion to that which may be installed in a given situation. Samples shall be organized by color schemes with a separate sample for each scheme. The schemes shall be coordinated by room names and numbers shown on the architectural floor plans. Colors shall be labeled with generic color names. Project title and location (Base) shall be placed in the lower right-hand corner of each module. Where special finishes such as architectural concrete, carpet, or prefinished textured metal panels are required, separate samples not less than 8 inches x 10 inches square shall be submitted with the board. If more space is needed, more than one board per set may be submitted. The Contractor shall certify that he has reviewed the color boards in detail and that they are in strict accordance with the contract drawings and specifications except as may be otherwise explicitly stated. Submittal of the color board shall not relieve the Contractor of the responsibility to submit the samples required by the Technical Specifications.

3.8 AS-BUILT DRAWINGS:
(Internet Address:http://www.cbbs.spk.usace.army.mil/html/aeguide.html.)

3.8.1 **Definitions**

3.8.1.1 Working As-Built Drawings. The contractor shall maintain a current record of the work as actually constructed in the form of working as-built drawings. These will typically be red-line mark-ups of the construction plans. The quantity of sets to be red-lined can be found under the paragraph below, Submittal Requirements for Review and Approval. It is the contractor’s responsibility to ensure the use of the most current drawings. Subject to the approval of the Contracting Officer, a member of the Contractor’s Quality Control Organization will be assigned the sole responsibility for the maintenance and currency of the as-built drawings. Any reassignment of duties concerning the maintenance of the as-built drawings will be promptly reported to the Contracting Officer. Guidelines & drafting standards for preparing working and final as-built drawings can be found on the Internet.

These instructions include submittal requirements for shop drawings.

3.8.2 **Final As-Built Drawings**. The contractor shall prepare final, record copy drawings which depict the actual conditions upon completion of construction. The deliverable required shall be in both hard copy and electronic format.

3.8.3 **Submittal Requirements for Review and Approval.**

3.8.3.1 Timeframes

3.8.3.1.1 Working as-built drawings.(GA) Three sets of red-line markups shall be submitted after the completion of each major phase of work (or bid items, if appropriate), in conjunction with approval of progress payments.

3.8.3.2 Final as-built drawings.(GA) All three sets of red-line markups and one new set (hard copy bond or blue-line) of completed final as-built drawings shall be submitted for review within 10 working days prior to the pre-final inspection. If upon review, the drawings are found to contain errors and/or omissions, they shall be returned to the Contractor for corrections.

Within 15 calendar days after the final project inspection, the Contractor shall submit for approval the one copy of updated red-line mark-up CADD files depicting final as-built conditions. If upon review by the Sacramento District, the drawings are found to contain errors and/or omissions, they shall be returned to the Contractor for corrections.

Within 45 calendar days after the final inspection, the Contractor shall transfer the final as-built drawings to the Government according to paragraph, <u>End-User (Customer Requirements)</u>.

3.8.4 **End-User (Customer) Requirements**

3.8.4.1 CADD Format: AutoCAD Release 14 for use on NT 4.0 Operating

3.8.4.1.1 Delivering electronic files. Specific instructions for labeling disks or CD-ROMs, directory structure, indexing and additional documentation requirements are listed on the Internet.

3.9 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."

3.10 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. Three (3) copies of the submittal will be retained by the Contracting Officer and one (1) copies of the submittal will be returned to the Contractor.

3.11 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. 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.

3.12 STAMPS

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

CONTRACTOR

(Firm Name)

_____ Approved

_____ Approved with corrections as noted on submittal data and/or attached sheets(s).

SIGNATURE: _____

TITLE: _____

DATE: _____

-- End of Section --

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02050

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Work Plan					X						X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02210

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.10	Field Testing Control					X						X											
			3.10	Field Testing Control						X					X											
			1.4.2	Satisfactory Materials						X					X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02221

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Field Density Tests						X						X										
			1.4	Testing of Backfill Materials						X						X										

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02222

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Field Density Tests						X					X											
			1.4	Testing of Backfill Materials						X					X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02230

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.4.1	Materials Other Than Salable Timber									X		X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02241

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.7	Plant, Equipment, Machines, and	X										X											
				Tools																						
			1.9	Sampling and Testing						X					X											
			1.4	Field Density						X					X											
			1.5	Waybills and Delivery Tickets									X		X											
			2.1.1.1	Coarse Aggregate									X		X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02285

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Qualifications	X										X											
			1.2	Pesticides			X								X											
			1.2	Pesticides								X			X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02511

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.8	Field Quality Control						X					X											
			2.1	Concrete									X		X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02512

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	FIO.																						
			1.2	FIO.																						

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02513

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Bituminous Pavement						X					X											

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CONTRACT NO.

TITLE AND LOCATION
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SPECIFICATION SECTION
02558

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Tests						X					X											
			1.2	Waybills and Delivery Tickets									X		X											

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Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
02580

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Equipment Lists	X											X										
			1.2	Mixing, Thinning and Application			X								X											
			1.2	Material Tests						X					X											
			1.2	Volatile Organic Compound (VOC)							X				X											
				Content																						

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SPECIFICATION SECTION
02660

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.1	Installation			X								X											
			1.4	Waste Water Disposal Method					X						X											
			1.4	Satisfactory Installation					X						X											
			3.3.1	Bacteriological Disinfection						X					X											
			1.3	Manufacturer's Representative							X				X											
			3.1	Installation							X				X											

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SPECIFICATION SECTION
02685

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Pipe, Fittings, and Associated		X									X											
				Materials																						
			1.3	Equipment and Materials				X							X											
			1.3	Spare Parts Data				X							X											
			1.3	Notification				X							X											
			1.2.1	Welding Steel Piping					X						X											
			1.2.2	Jointing Polyethylene and Fiberglass					X							X										
				Piping																						
			1.3	Connection and Abandonment					X							X										
				Procedures																						
			1.3	Utility Work							X				X											
			1.3	Training							X				X											
			1.3	Gas Distribution System										X	X											

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SPECIFICATION SECTION
02698

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Distribution System	X										X											
			1.3	Distribution System		X									X											
			1.3	Distribution System							X				X											
			1.3	Welding Procedures and Operators							X				X											
			1.3	Distribution System										X	X											

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SPECIFICATION SECTION
02720

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.3	Placing Pipe			X								X											
			1.2	Resin Certification							X				X											
			3.7	Pipeline Testing							X				X											
			3.6.4	Determination of Density							X															
			1.2	FIP							X															
			2.3.3	Frame and Cover for Gratings							X				X											

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SPECIFICATION SECTION
02730

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Portland Cement							X				X											

ENG FORM 4288, Jul 96

SPECSINTACT

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SPECIFICATION SECTION
02811

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Design Analysis and Calculations	X											X										
			1.4	Spare Parts	X											X										
			1.4	Sprinkler System		X										X										
			1.4	Field Tests						X						X										
			1.4	Operations & Maintenance Manuals						X						X										
			1.4	Sprinkler System							X					X										

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TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
02870

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.6	Manufacturer Information	X											X										
			1.6	Shop Drawings		X									X											

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TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
02935

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Manufacturer's Literature	X										X											
			1.3	Equipment List				X							X											
			1.3	Delivery					X						X											
			3.7	Application of Pesticide					X						X											
			3.10.3.7	Maintenance Report					X						X											
			3.10	Turf Establishment Period					X						X											

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TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
02950

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Delivery Schedule				X							X											
			1.2	Soil Test						X					X											
			1.2	Percolation Test						X					X											
			1.2	Soil Amendments;							X				X											
			1.2	Plants;							X				X											
			1.2	Maintenance Period;									X		X											
			1.2	Maintenance Report;									X		X											
			1.2	Maintenance Instructions;									X		X											

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SPECIFICATION SECTION
03100

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Design	X											X										
			1.2	Concrete Formwork	X										X											
			1.2	Concrete Formwork		X									X											
			2.1.6	Form Releasing Agents			X								X											

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SPECIFICATION SECTION
03200

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Concrete Reinforcement System		X										X										
			1.3	Qualifications					X						X											
			2.2	Reinforcing Steel							X				X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
03250

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Materials	X										X											
			1.2	Materials							X					X										

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CONTRACT NO.

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SPECIFICATION SECTION
03300

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Mixture Proportions					X							X										
			3.4	Sampling and Testing						X					X											
			2.2	Cementitious Materials							X				X											

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SPECIFICATION SECTION
04200

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Concrete Masonry Units	X																					
			1.2	GAFIO	X																					
			1.2	Masonry Work		X									X											
			3.1.2	Cold Weather Installation					X						X											
			1.2	Efflorescence Test						X					X											
			3.19.1	Field Testing of Mortar						X					X											
			3.19.2	Field Testing of Grout						X					X											
			1.2	Prism tests						X					X											
			1.2	Masonry Cement						X					X											
			1.5	Special Inspection						X					X											
			2.2	Concrete Masonry Units (CMU)							X				X											
			2.9	Control Joint Keys							X				X											
			2.6	Anchors, Ties, and Bar Positioners							X				X											
			2.10	Expansion-Joint Materials							X				X											
			2.7	Joint Reinforcement							X				X											
			2.8	Reinforcing Steel Bars and Rods							X				X											
			1.2	Masonry Cement							X				X											
			1.2	Mortar Coloring							X				X											
			2.3	Precast Concrete Items							X				X											
			1.2	Mortar Admixtures							X				X											
			1.2	Grout Admixtures							X				X											
			2.2	Concrete Masonry Units (CMU)								X			X											
			2.6	Anchors, Ties, and Bar Positioners								X			X											
			1.2	Expansion-Joint Material								X			X											
			2.7	Joint Reinforcement								X			X											

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SPECIFICATION SECTION
05120

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Structural Steel System		X									X											
			1.3	Structural Connections		X										X										
			3.2	Erection					X						X											
			1.3	Mill Test Reports							X				X											
			1.3	Welder Qualifications							X				X											
			3.1	Fabrication							X				X											
			2.4	High Strength Bolts and Nuts								X			X											
			1.3	Carbon Steel Bolts and Nuts								X			X											
			2.6	Nuts Dimensional Style								X			X											
			2.7	Washers								X			X											

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(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
05210

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Steel Joists		X									X											
			1.2	Steel Joists							X				X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
05300

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Deck Units	X										X											
			2.1	Deck Units		X									X											
			2.5	Accessories		X									X											
			3.3	Attachments		X									X											
			3.4	Holes and Openings		X									X											
			2.1	Deck Units							X				X											
			3.3	Attachments							X				X											
			2.1	Deck Units								X			X											
			2.5	Accessories								X			X											
			3.3	Attachments									X		X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
05400

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Studs, Tracks, Bracings,																						
				Purlins/Joists, and Struts																						
			1.2.2.1	Framing drawings		X																				
			1.2.3.1	Metal framing calculations																						

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CONTRACT NO.

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CONTRACTOR

SPECIFICATION SECTION
05500

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Miscellaneous Metal Items		X									X											
			1.2	Miscellaneous Metal Items								X			X											

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CONTRACT NO.

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SPECIFICATION SECTION
06100

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1.1	Grading and Marking							X				X											
			2.3	Insulation							X				X											

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CONTRACT NO.

TITLE AND LOCATION
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SPECIFICATION SECTION
06200

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Finish Carpentry		X									X											
			2.1.5	Moldings								X			X											
			2.1.4	Sills and Trim								X			X											

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SPECIFICATION SECTION
06410

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.5	Cabinets		X										X	GA									

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
06650

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Products	X										X											
			1.3	Maintenance	X										X											
			1.3	Shower Benches		X										X										
			1.3	Shower Benches								X				X										

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
07112

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Reinforcing Fabric	X										X											
			1.2	Protection Board	X										X											
			1.2	Application			X								X											
			1.2	Materials							X				X											

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SPECIFICATION SECTION
07180

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Materials	X										X											
			1.2	Volatile Organic Compound (VOC)							X				X											
				Content																						
			1.2	Materials								X			X											
			1.2	Qualifications of the Applicator									X		X											

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Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
07220

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.5	Application of Insulation			X																			
			1.2	FIO]			X																			
			1.2	Inspection					X						X											
			2.1	Insulation							X				X											
			1.2	Organic Roofing Felt							X				X											

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Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
07240

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Exterior Insulation and Finish System			X								X											
			1.4	Exterior Insulation and Finish System						X					X											
			1.4	Exterior Insulation and Finish System								X				X										
			1.4	Manufacturer's Approval and License					X						X											

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Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
07320

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Concrete Tile Roof System	X											X										
			1.2	Concrete Tile Roof System		X										X										
			1.3	Qualifications					X						X											
			1.2	Certificates of Compliance							X				X											
			1.2	Concrete Roofing Tiles								X				X										
			1.2	Sealants								X			X											
			1.2	Underlayment Sheet								X			X											
			1.2	Fasteners								X			X											

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TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
07600

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Materials		X									X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
07900

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Backing	X										X											
			2.2	Bond-Breaker	X										X											
			2.4	Sealant	X										X											
			2.4	Sealant							X				X											

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SPECIFICATION SECTION
08110

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Steel Doors and Frames		X									X											
			2.2	Sound Rated Doors							X				X											
			1.2	Steel Doors and Frames								X			X											

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CONTRACT NO.

TITLE AND LOCATION
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SPECIFICATION SECTION
08120

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Aluminum Doors and Frames	X										X											
			1.4	Aluminum Doors and Frames		X									X											
			3.1.2	Installation			X								X											
			1.4	Cleaning			X								X											
			1.4	Full-Glazeds						X					X											
			2.1.1	Finishes								X			X											

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SPECIFICATION SECTION
08210

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Wood Doors		X									X											
			1.3	Adhesives							X				X											
			2.6.1	Factory Coated Natural Finish								X			X											

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CONTRACT NO.

TITLE AND LOCATION
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SPECIFICATION SECTION
08353

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.2	Accordion Partitions	X											X										
			2.2	Accordion Partitions		X										X										
			1.2	Materials							X				X											
			2.2	Accordion Partitions							X				X											
			2.2	Accordion Partitions								X				X										
			2.2	Accordion Partitions										X	X											

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SPECIFICATION SECTION
08520

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Aluminum Windows	X										X											
			1.3	Aluminum Windows		X									X											
			1.3	Aluminum Windows			X								X											
			1.3	Aluminum Windows						X					X											
			1.3	Aluminum Windows							X				X											
			1.3	Aluminum Windows								X			X											

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SPECIFICATION SECTION
08700

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Hardware and Accessories	X										X											
			1.2	Hardware Devices		X										X										
			1.2	Hardware Schedule				X							X											
			1.2	Keying Schedule				X								X										
			1.2	Hardware and Accessories							X				X											

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SPECIFICATION SECTION
08810

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Glass	X										X											
			1.2	Glazing Accessories	X										X											
			1.2	Glazing Materials and Accessories		X									X											
			1.2	Glass							X				X											
			1.2	Glass								X			X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
09250

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Steel Framing		X									X											
			1.2	Control Joints		X									X											
			1.2	Gypsum Wallboard							X				X											
			2.3.2	Water-Resistant Gypsum Board							X				X											
			1.2	Steel Framing							X				X											

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CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
09310

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Tile	X										X											
			2.2	Setting-Bed	X										X											
			2.4	Mortar, Grout, and Adhesive	X										X											
			2.1	Tile			X								X											
			1.2	Mortar and Grout			X								X											
			1.2	Testing						X					X											
			2.1	Tile							X				X											
			2.4	Mortar, Grout, and Adhesive							X				X											
			2.1	Tile								X				X										
			2.1.3	Accessories								X				X										
			2.5	Marble Thresholds								X				X										

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Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
09510

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Acoustical Ceiling System	X										X											
			1.3	Acoustical Ceiling System		X									X											
			2.7	Ceiling Attenuation Class and Test						X					X											
			2.1	Acoustical Units							X				X											
			2.1	Acoustical Units								X				X										

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Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
09650

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Resilient Flooring and Accessories	X											X										
			1.2	Resilient Flooring and Accessories						X					X											
			1.2	Resilient Flooring and Accessories								X				X										

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SPECIFICATION SECTION
09680

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Carpet and Accessories	X											X										
			3.4	Installation		X									X											
			1.2	Carpet and Accessories			X								X											
			1.2	Moisture and Alkalinity Tests						X					X											
			1.2	Carpet and Accessories							X				X											
			1.2	Carpet and Accessories								X				X										
			1.2	Carpet and Accessories										X	X											

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SPECIFICATION SECTION
09900

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Paint	X										X											
			3.3	Mixing and Thinning			X								X											
			3.4	Application			X								X											
			2.1	Paint						X					X											
			2.1.2	Lead							X				X											
			1.2	Mildewcide and Insecticide							X				X											
			2.1.4	Volatile Organic Compound (VOC)							X				X											
				Content																						
			2.1	Paint								X			X											

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SPECIFICATION SECTION
10160

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Toilet Partition System	X										X											
			1.3	Toilet Partition System		X									X											
			1.3	Toilet Partition System								X				X										

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SPECIFICATION SECTION
10250

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Shop Drawings		X									X		GA									

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SPECIFICATION SECTION
10260

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.2	Corner Guards	X											X										
			2.3	Wall Guards (Bumper Guards)	X											X										
			2.2	Corner Guards		X									X											
			2.3	Wall Guards (Bumper Guards)		X									X											
			2.2	Corner Guards							X				X											
			2.3	Wall Guards (Bumper Guards)							X				X											
			2.5	Finish								X				X										

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SPECIFICATION SECTION
10270

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Raised Floor System	X										X											
			1.3	Raised Floor System		X										X										
			1.3	Tests						X																
			1.3	GA]						X																
			1.3	Testing of Electrical Resistance						X						X										
			1.3	Raised Floor System							X				X		FIO									

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SPECIFICATION SECTION
10440

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Interior Signage	X										X											
			1.3	Interior Signage		X									X											
			1.3	Interior Signage								X				X										

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Vandenberg AFB, Space IQT Academic Facility

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SPECIFICATION SECTION
10500

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.2	Locker Manufacturer's Catalog	X										X											
			1.2	Single Tier Lockers		X									X											
			1.2	Box Lockers		X									X											
			1.2	Color Chips								X				X										

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SPECIFICATION SECTION
10800

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1.2	Finishes	X										X											
			2.2	Accessory Items	X										X											
			2.1.2	Finishes								X														
			1.2	FIO]								X														
			2.2	Accessory Items								X			X											

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SPECIFICATION SECTION
12520

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Window Treatments and Hardware	X										X											
			1.3	Window Treatments and Hardware		X									X											
			1.3	Window Treatments and Hardware								X				X										

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SPECIFICATION SECTION
12690

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.1	Recessed Floor Grids											X											
			1.1	Carpet Tread, Tread Rails and		X									X											
				Frames																						
			1.1	Carpet Tread								X				X										
			1.1	Tread Rails								X				X										

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13080

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.1	Bracing and Coupling	X										X											
			3.13	Lighting Fixtures in Buildings	X										X											
			3.12	Miscellaneous Equipment	X										X											
			3.1	Bracing and Coupling		X									X											
			3.3	Flexible Couplings or Joints		X									X											
			3.7	Resilient Vibration Isolation Devices		X									X											
			3.13	Lighting Fixtures in Buildings		X									X											
			3.12	Miscellaneous Equipment		X									X											
			2.1.3.1	Flexible Ball Joints							X				X											

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SPECIFICATION SECTION
13814

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Equipment and Performance	X																					
			1.3	Equipment and Material		X																				
			1.3	Test Plan					X																	
			1.3	Test Procedure					X																	
			3.4	Site Testing						X																

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15250

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Thermal Insulation Materials								X														

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15330

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Load Calculations for Sizing Sway	X																					
				Bracing																						
			1.3	Sprinkler System Equipment	X																					
			1.4	Hydraulic Calculations	X																					
			1.3	Spare Parts	X																					
			1.3	Sprinkler System Shop Drawings		X																				
			1.3	As-Built Drawings		X																				
			1.3	Test Procedures			X																			
			1.3	Preliminary Tests				X																		
			1.3	Final Test				X																		
			1.6	Installer Qualifications					X																	
			1.5	Submittal Preparer's Qualifications					X																	
			1.3	Contractor's Material & Test							X															
				Certificates																						
			1.3	Sprinkler System										X												

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SPECIFICATION SECTION
15400

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.5	Welding	X																					
			3.4	Vibration-Absorbing Features	X																					
			1.5	Plumbing System		X																				
			1.5	Electrical Schematics		X																				
			1.5	Plumbing System			X																			
			3.9	Tests, Flushing and Sterilization						X																
			1.5	Backflow Prevention Assembly Tests						X					X											
			1.5	Materials and Equipment							X															
			1.5	Bolts							X															
			1.5	Plumbing System										X												

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SPECIFICATION SECTION
15488

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Qualifications	X																					
			1.3	Gas Piping System		X																				

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15569

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Manufacturer's Catalog Data	X																					
			1.3	Spare Parts Data	X																					
			1.3	Water Treatment Plan	X																					
			1.3	Heating and Fuel Systems Test	X																					
				Procedures																						
			1.3	Welding Procedures	X																					
			1.3	Qualification	X																					
			1.3	Welding Qualification	X																					
			1.3	Heating System		X																				
			1.3	Posted Instructions			X																			
			1.3	Tests				X																		
			1.3	Heating System and Fuel System						X																
				Tests																						
			1.3	Water Treatment Tests						X																
			1.3	Bolts							X															
			1.3	Boiler Emissions							X															
			1.3	Heating System										X												
			1.3	Water Treatment System										X												

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SPECIFICATION SECTION
15650

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Central Refrigerated Air-Conditioning	X																					
				System																						
			2.8	Water Treatment Systems	X																					
			1.3	Spare Parts	X																					
			1.4	Qualifications	X																					
			1.3	Central Refrigerated Air-Conditioning		X																				
				System																						
			1.3	Posted Instructions			X																			
			2.11	Factory Tests				X																		
			3.2	Tests				X																		
			3.6	Demonstrations				X																		
			1.7.1	Verification of Dimensions					X																	
			2.11	Factory Tests						X																
			3.2.1	Field Tests						X																
			1.3	System Performance Tests						X																
			1.3	Central Refrigerated Air-Conditioning							X															
				System																						
			1.3	Operation Manual										X												
			1.3	Maintenance Manual										X												
			1.3	Water Treatment System										X												

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ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Components and Equipment Data	X																					
			1.4	Air Supply, Distribution, Ventilation,		X																				
				and Exhaust Equipment																						
			1.4	Test Procedures			X																			
			1.4	Welding Procedures			X																			
			1.4	System Diagrams			X																			
			1.4	Test Schedules				X																		
			1.4	Field Training Schedule				X																		
			1.4	Similar Services					X																	
			1.4	Welding Qualification					X																	
			1.4	Test Reports						X																
			1.4	Bolts							X															
			1.4	Air Supply, Distribution, Ventilation,										X												
				and Exhaust Manuals																						

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15951

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Equipment Data	X																					
			1.3	System Descriptions and Analyses	X																					
			1.3	Software	X																					
			1.3	System Overall Reliability	X																					
				Calculations																						
			1.3	Training Data	X											X										
			1.3	Data Entry Forms	X											X										
			1.3	System Drawings		X																				
			1.3	Factory Testing					X							X										
			1.3	Site Testing					X							X										
			1.3	Performance Verification Testing and					X																	
				Endurance Testing																						
			1.3	Commissioning Procedures					X																	
			1.3	Test Reports						X																
			1.3	Performance Verification and						X																
				Endurance Report																						
			1.3	Control System Calibration,						X																
				Adjustments, and Commissioning																						
			1.3	Operation and Maintenance Manuals										X												
			1.3	Functional Design Manual										X												
			1.3	Hardware Manual										X												
			1.3	Software Manual										X												
			1.3	Operator's Manual										X												
			1.3	Maintenance Manual										X												

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ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			3.1	Testing and Balancing						X																
			1.4	Qualification							X															

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			1.1	Commissioning Team	X																					
			1.1	Test Procedures			X																			
			1.1	Test Schedule				X																		
			1.1	Test Reports						X																

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ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			2.1	Components	X											X										
			1.2	Insert Duct	X											X										
			2.5	Blank Ducts	X											X										
			2.7	Service Outlet Fittings	X											X										
			1.2	Trench Duct	X											X										
			3.1	Duct System		X										X										
			1.2	As-Built Drawing		X									X											
			3.1	Duct System			X								X											
			1.2	Equipment and Materials				X							X											
			2.7	Service Outlet Fittings								X			X											
			3.1	Duct System										X	X											

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SPECIFICATION SECTION
16311

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Structural Calculations	X											X										
			1.3	Fault Current and Protective Devices	X											X										
				Coordination Studies																						
			1.3	Battery Calculations	X											X										
			1.3	Manufacturer's Catalog	X																					
			1.3	FIO	X																					
			1.3	Material, Equipment, and Fixture	X										X											
				Lists																						
			1.3	Installation Procedures	X										X											
			1.3	As-Built Drawings	X										X											
			1.3	On-Site Test					X							X										
			1.3	Factory Test Reports						X						X										
			1.3	Field Test Plan						X						X										
			1.3	Field Test Reports						X						X										
			1.3	Materials and Equipment							X				X											
			1.3	Electric Supply Station										X	X											

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ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Fault Current and Protective Device	X																					
				Coordination Study																						
			1.3	GA	X																					
			1.3	Manufacturer's Catalog	X										X											
			1.3	Material, Equipment, and Fixture	X										X											
				Lists																						
			1.3	Electrical Distribution System		X									X											
			1.3	As-Built Drawings		X									X											
			1.3	Factory Test						X					X											
			3.5.8	Field Testing						X					X											
			1.3	Test Reports						X						X										
			1.3	Materials and Equipment							X				X											
			1.3	Electrical Distribution System										X	X											

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16375

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Fault Current and Protective Devices	X											X										
				Coordination Studies																						
			1.3	Manufacturer's Catalog Data	X										X											
			1.3	Material, Equipment, and Fixture	X										X											
				Lists																						
			1.3	Installation Procedures	X											X										
			1.3	Electrical Distribution System		X									X											
			1.3	As-Built Drawings		X									X											
			1.3	Factory Test						X					X											
			1.3	Field Testing						X						X										
			1.3	Test Reports						X						X										
			1.3	Cable Installation Reports						X						X										
			1.3	Materials and Equipment							X				X											
			1.3	Cable Splicer Qualification							X				X											
			1.3	Cable Installer Qualifications							X				X											
			1.3	Electrical Distribution System										X		X										

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16415

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Fault Current and Protective Device	X											X										
				Coordination Study																						
			1.3	Manufacturer's Catalog	X										X											
			1.3	Material, Equipment, and Fixture	X										X											
				Lists																						
			1.3	Installation Procedures	X										X											
			1.3	Interior Electrical Equipment		X										X										
			1.3	As-Built Drawings		X									X											
			1.3	On-Site Test					X							X										
			1.3	Factory Test Reports						X						X										
			1.3	Field Test Plan						X						X										
			1.3	Field Test Reports						X						X										
			1.3	Materials and Equipment							X					X										

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16528

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Equipment and Materials	X										X											
			1.4	Spare Parts	X										X											
			1.4	Lighting System		X										X										
			1.4	As-Built Drawings		X									X											
			1.4	Operating Test						X					X											
			1.4	Ground Resistance Measurements						X					X											
			1.4	Lighting System										X	X											

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			1.3	UPS System Performance Data	X											X										
				Sheets																						
			1.3	Spare Parts	X										X											
			1.3	Lesson Plans and Training Manuals	X											X										
			1.3	UPS System		X										X										
			1.3	Factory and Field Tests						X						X										

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16640

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Cathodic Protection System	X										X											
			1.3	Qualifications	X										X											
			1.3	Cathodic Protection System		X									X											
			3.3	Tests and Measurements						X					X											

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			1.5	Spare Parts	X										X											
			1.5	Premises Distribution System		X										X										
			1.5	Record Drawings		X										X										
			1.5	Manufacturer's Recommendations			X									X										
			1.5	Test Plan					X							X										
			1.4	Qualifications					X							X										
			1.5	Test Reports						X						X										
			1.5	Premises Distribution System							X					X										
			2.1	Materials and Equipment							X					X										
			1.5	Installers							X					X										
			1.8	Record Keeping and Documentation									X			X										

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			1.2	Spare Parts	X										X											
			1.2	Telephone System		X										X										
			1.2	Test Plans					X						X											
			3.4	Acceptance Tests						X					X											
			1.2	Installation Procedures						X						X										
			1.2	Telephone System							X				X											

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SPECIFICATION SECTION
16721

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.4	Battery	X											X										
			1.4	Voltage Drop	X										X											
			1.4	Spare Parts	X											X										
			1.4	Qualifications	X											X										
			1.4	Fire Alarm Reporting System		X										X										
			1.4	Fire Alarm Reporting System			X									X										
			1.4	Training			X								X											
			1.4	Test Procedures					X							X										
			1.4	Testing						X						X										
			1.4	Equipment							X					X										
			1.4	Installer							X				X											

SUBMITTAL REGISTER
(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION
Vandenberg AFB, Space IQT Academic Facility

CONTRACTOR

SPECIFICATION SECTION
16760

ACTIVITY NO. a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O&M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERN-MENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Spare Parts	X																					
			1.3	FIO..	X																					
			1.3	Intercommunication System		X																				
			1.3	GA..		X																				
			1.3	Test Plan and Procedures						X																
			1.3	FIO..						X																
			3.3	Acceptance Tests						X																
			1.3	Intercommunication System										X												
			1.3	FIO..										X												

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SECTION 01410

ENVIRONMENT PROTECTION

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SECTION 01410

ENVIRONMENT PROTECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

The Contractor shall perform the work minimizing environmental pollution and damage as the result of construction operations. Environmental pollution and damage is 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; affect other species of importance to humankind; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of land, water, and air, and includes management of visual aesthetics, noise, solid, chemical, gaseous, and liquid waste, radiant energy and radioactive materials, as well as other pollutants. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract.

1.1.1 Subcontractors

The Contractor shall ensure compliance with this section by subcontractors.

1.1.2 Environmental Protection Plan

The Contractor shall submit an environmental protection plan within 15 days after receipt of the notice to proceed. Approval of the Contractor's plan will not relieve the Contractor of responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include, but shall not be limited to, the following:

a. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

b. Methods for protection of features to be preserved within authorized work areas like trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological, and cultural resources.

(1) It is intended that the natural and cultural resources within the project boundaries and outside the limits of permanent work performed under this contract be preserved in their present condition or be restored in accordance with the Vandenberg AFB Land Management Plan. The Contractor shall confine project-related activities to areas defined by the plans or specifications. The Contractor shall mark the construction limits using 36-

inch stakes placed no further than 25 feet apart. These stakes must remain in place for the duration of the project. After staking, the construction limits will be inspected and must be approved by Base Environmental Management personnel prior to start of construction. The Contractor shall brief all employees and subcontractors on the purpose of the stakes. Any encroachment outside the staked area may result in project delays and increased environmental costs for which the Contractor shall be liable.

c. Procedures to be implemented to provide the required environmental protection, to comply with the applicable laws and regulations, and to correct pollution due to accident, natural causes, or failure to follow the procedures of the environmental protection plan.

d. Location of the solid waste disposal area.

e. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

f. Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.

(1) All construction activity performed on Vandenberg AFB is subject to federal environmental laws including, but not limited to: The National Environmental Policy Act (NAPA); The National Historic Preservation Act (NAPA); Endangered Species Act; Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response Liability and Compensation Act (CERLCA); Clean Water Act (CWA); Clean Air Act (CAA); Safe Drinking Water Act (SDWA), and applicable state, regional, and local equivalents. The Contractor is responsible for compliance with these laws. The Environmental Management Office, 30 SPW/ET, is the single point of contact with regulatory agencies

(2) The Contractor shall comply with all Santa Barbara County Air Pollution Control District (APCD) rules and regulations. These include, but are not limited to, the following:

(a) All demolition, site clearing, rough grading, landscape grading, excavation, backfilling, and trenching shall comply with APCD Rules 210, 302, 303, 304, and 306.

(b) All coating/painting operations shall comply with APCD Rules 102FF, 201, 317, 322, 323, 330, 337 and 339.

(c) All construction of new or modified air-conditioning systems shall comply with APCD Rule 335.

(d) All operations with solvents shall comply with APCD Rule 317 and 324.

(e) All sandblasting/corrosion control operations shall comply with California Administrative Code, Title 17, Register 84, No. 35, Sections 92000 through 92540, and shall comply with APCD Rules 303, 304, 306, 205.C.3.b.1, 901, and 1001. All sandblasting equipment must be permitted with a valid Permit to Operate (PTO) from the APCD. Only abrasives which are certified for use in sandblasting operations by the California Air Resources Board (CARB) Advisory may be used.

(3) <u>Hazardous materials:</u>

(a) The Contractor shall be responsible for the removal, storage, transportation, and disposal of all hazardous waste (Title 22, CCR) and designated waste (Title 23, CCR) in accordance with applicable federal, state, local, and base regulations. Copies of all analyses and manifests shall be given to the Government inspector at the time of removal from base and after disposal facility accepts and signs for the waste. Hazardous waste manifests will be signed by 730 CES/CEVC personnel only. Suspected hazardous materials encountered during excavation and construction will require immediate notification of Bioenvironmental Engineering Services (Base Hospital) for examination, possible sampling, and guidance for management. If hazardous or designated waste is identified after award, a negotiated equitable adjustment will be made to the Contract.

(b) Any electrical equipment removed, maintained or repaired as part of this Contract shall be tested for polychlorinated biphenyls (PCBs), a regulated hazardous waste. Testing and laboratory analyses shall be paid for by the Contractor. Testing, removal, storage, transportation and disposal of this material shall follow federal, state and base guidelines. This may include but is not limited to the following: 40 CFR 761 (Federal); Title 22 CCR (California); and OPLAN 8550-XX (VAFB).

(c) Removal of any underground storage tank (UST) shall be coordinated with the 30 CDG monitor, 6-8095. The Contractor may be required to obtain an (Application for Permit to Remove" from the Santa Barbara County Health Care Service.

1.1.3 Permits

The Contractor shall obtain all needed permits or licenses. The Government will not obtain any permits for this project; see Contract Clause PERMITS AND RESPONSIBILITIES. [The State department of natural resources, through the national pollutant discharge elimination system (NPDES), requires general permits, a notice of intent, and a notice of discontinuation. The Contractor shall be responsible for implementing the terms and requirements of the appropriate permits as needed and for payment of all fees.]

1.1.4 Preconstruction Survey

Prior to starting any onsite construction activities, the Contractor and the Contracting Officer shall make a joint condition survey after which the Contractor shall prepare a brief report indicating on a layout plan the condition of trees, shrubs and grassed areas immediately adjacent to work sites and adjacent to the assigned storage area and access routes as applicable. This report will be signed by both the Contracting Officer and the Contractor upon mutual agreement as to its accuracy and completeness.

1.1.5 Meetings

The Contractor shall meet with representatives of the Contracting Officer to alter the environmental protection plan as needed for compliance with the environmental pollution control program.

1.1.6 Notification

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the previously mentioned Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such

notice, inform the Contracting Officer of proposed corrective action and take such action when approved. If the Contractor fails 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 time extensions shall be granted or costs or damages allowed to the Contractor for any such suspensions.

1.1.7 Litigation

If work is suspended, delayed, or interrupted due to a court order of competent jurisdiction, the Contracting Officer will determine whether the order is due in any part to the acts or omissions of the Contractor, or subcontractors at any tier, not required by the terms of the contract. If it is determined that the order is not due to Contractor's failing, such suspension, delay, or interruption shall be considered as ordered by the Contracting Officer in the administration of the contract under the contract clause SUSPENSION OF WORK.

1.1.8 Previously Used Equipment

The Contractor shall thoroughly clean all construction equipment previously used at other sites before it is brought into the work areas, ensuring that soil residuals are removed and that egg deposits from plant pests are not present; the Contractor shall consult with the USDA jurisdictional office for additional cleaning requirements.

1.1.9 Payment

No separate payment will be made for work covered under this section; all costs associated with this section shall be included in the contract unit and/or lump sum prices in the Bidding Schedule.

1.2 LAND RESOURCES

The Contractor shall confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify the land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without permission. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Stone, earth or other material displaced into uncleared areas shall be removed.

1.2.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

1.2.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

1.2.3 Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in cases where the constructed feature obscures borrow areas, quarries, and waste material areas, these areas shall not initially be totally cleared. Clearing of such areas shall progress in reasonably sized increments as needed to use the developed areas as approved by the Contracting Officer.

1.2.4 Disturbed Areas

The Contractor shall effectively prevent erosion and control sedimentation through approved methods including, but not limited to, the following:

a. Retardation and control of runoff. Runoff from the construction site or from storms shall be controlled, retarded, and diverted to protected drainage courses by means of diversion ditches, benches, berms, and by any measures required by area wide plans under the Clean Water Act.

b. Erosion and sedimentation control devices. The Contractor shall construct or install temporary and permanent erosion and sedimentation control features as indicated on the drawings. Berms, dikes, drains, sedimentation basins, grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

c. Sediment basins. Sediment from construction areas shall be trapped in temporary or permanent sediment basins in accordance with the drawings. The basins shall accommodate the runoff of a local 5 year storm. After each storm, the basins shall be pumped dry and accumulated sediment shall be removed to maintain basin effectiveness. Overflow shall be controlled by paved weirs or by vertical overflow pipes. The collected topsoil sediment shall be reused for fill on the construction site, and/or stockpiled for use at another site. The Contractor shall institute effluent quality monitoring programs as required by State and local environmental agencies.

1.2.5 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Borrow areas shall be managed to minimize erosion and to prevent sediment from entering nearby waters. Spoil areas shall be managed and controlled to limit spoil intrusion into areas designated on the drawings and to prevent erosion of soil or sediment from entering nearby waters. Spoil areas shall be developed in accordance with the grading plan indicated on the drawings. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas from despoilment.

1.3 WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation when such application may cause contamination of the fresh water reserve. Monitoring of water areas affected by construction shall be the Contractor's responsibility. All water areas affected by construction activities shall be monitored by the Contractor.

1.3.1 Washing and Curing Water

****
NOTE: Insert name of process producing the wastewater. Remove last sentence when an analysis is not required.
****

Waste waters directly derived from [_____] [construction activities] shall not be allowed to enter water areas. Waste waters shall be collected and placed in retention ponds where suspended material can be settled out or the water evaporates to separate pollutants from the water. Analysis shall be performed and results reviewed and approved before water in retention ponds is discharged.

***** DELETE IF NOT NEEDED *****

1.3.2 Cofferdam and Diversion Operations

Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure shall be controlled at all times to limit the impact of water turbidity on the habitat for wildlife and on water quality for downstream use.

***** DELETE IF NOT NEEDED *****

1.3.3 Stream Crossings

Stream crossings shall allow movement of materials or equipment without violating water pollution control standards of the Federal, State or local government.

1.3.4 Fish and Wildlife

The Contractor shall minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed by the Contractor prior to beginning of construction operations.

***** CALIFORNIA AND NEVADA DESERT AREAS (EDWARDS, IRWIN, NELLIS, GEORGE, ETC.) *****

(A) Wild Life Encounters During Construction:

It is not anticipated that there will be an abundance of wild life encounters at the project site. However, should the Contractor discover animals living within the construction boundaries, operation shall be suspended at the site of discovery and continued in other areas. The Contractor shall notify the Contracting Officer and Biological Monitor immediately of the finding. Included with the notification shall be a brief

statement to the Contracting Officer and Biological Monitor of the location and the findings. How to identify sensitive animals that may be discovered will be provided at the Preconstruction Conference.

(B) Desert Tortoise:

Contractor employees shall not touch, harm, harass, or kill desert tortoises. The Biological Monitor shall be notified immediately of all desert tortoise sightings. The Biological Monitor will be responsible for removing desert tortoises out of immediate dangers. Should construction activities threaten the survival of any desert tortoises, those activities will immediately cease until the Biological Monitor safely removes the tortoise(s). The Biological Monitor shall perform clearance surveys in all areas of planned disturbance. The Biological Monitor will be available to accompany construction crews during period of tortoise activity to provide protection of these animals and their burrows.

(1) The Contractor shall implement an employees environmental awareness program which will be provided to construction and operation employees with information to encourage awareness and preservation of the desert ecosystem and the resources found in the **Western Mojave Desert**. This information shall be distributed to and discussed with all employees during employee orientation sessions. This information shall also be provided to all visitors and subcontractors that will be on-site. The Contractor shall have all persons participating in the environmental awareness program sign and affidavit declaring that the individual understands and will adhere to the guidelines set
forth in the program material.

(2) The Contractor shall develop a strict trash and litter control program. A litter control program shall consist of supplying an adequate number of covered trash and litter receptacles in all appropriate locations.

***** (CAMP ROBERTS) *****

(A) Protection of Fish and Wildlife Resources

(1) Kit Fox:

The Contractor shall do a pre-activity survey for Kit Fox presence that shall be conducted by a certified Kit Fox Biologist within 60 days physically starting construction of the project site. The survey shall cover all off road areas which will be impacted from ground disturbing activities associated with projects. The survey shall define a project zone for construction activities and exclusion zones shall be established around dens found within the project area. No ground disturbance or vehicle traffic is allowed within the exclusion zones. If an established roadway falls within an exclusion zone, vehicle traffic will be allowed only if critical need exists and alternate routes are not available. Foot traffic ell be allowed for transit only when necessary and when alternate routes are not available. Exclusion zones will be based on the following criteria:

a. Potential den, 15 m (50 feet) radius
b. Known den, 30 m (100 feet) radius
c. Known natal or pupping den, 45 m (150 feet) radius

(2) Dens

Potential dens are defined as dens (ground holes) having entrances of sufficient size to allow use by San Joaquin kit fox, and that occur in habitat suitable for kit fox. Known dens are those known to be currently inhabited by kit fox, or where kit fox have been observed in the past. Know natal or pupping dens are those dens where pregnant females or females with pups have been observed. The exclusion radius is measured from the center of a single den, or from the center of a group of dens.

(3) Zones

Exclusions zones shall be clearly staked, encircled with cord or tape, and flagged. Establishment of exclusion zones shall be done by a qualified wildlife biologist listed in submittal section.

(4) Vehicle Traffic

Construction activities shall be designed to minimize off road vehicle traffic. The contractor shall make use of existing roads, trails, and previously disturbed areas wherever possible. Parking and staging areas shall be clearly delineated to prevent unnecessary disturbance to the adjacent areas. All vehicle traffic shall be limited to 20 miles per hour, except where otherwise posted.

(5) Construction Activities

Construction activities shall be limited to the smallest possible area(s) of disturbance and night time construction activities are prohibited.

(6) Accidental Entrapment Measures

The following measures shall be implemented to avoid accidental entrapment of animals:

a. All steep-sided excavations greater than three (3) feet deep shall be covered or filled at the end of each working day or shall be equipped with earth or plank escape ramps. Escape ramps shall be placed at a 45 degree angle, 12 inches wide and continuous from the bottom of the excavation to the top.

b. All excavations shall be thoroughly inspected for animals prior to sealing or refilling to avoid accidental burial. Permanent and semi-permanent structures installed in ground or underground shall be constructed so that animals will not become trapped within.

c. Any pipe, culvert, or similar material with an inside diameter of four (4) inches or more shall be thoroughly inspected for animals prior to sealing or reconnecting. If animals are found inside the materials, the material shall not be used until the animal vacates or is conducted out of the area. Pipelines temporarily left open in place shall be covered or blocked until work is completed.

(7) Destruction of Dens

Planned, intentional destruction of dens may be allowed, but should be avoided except where absolutely necessary. Planned destruction of any den(s) shall require notification to the government representative who will provide written notification to the U. S. Fish and Wildlife Service, and

shall require their concurrence. Intentional den destruction shall occur only under the direct supervision of a certified kit fox biologist.

(8) Restoration of Areas

Contour and restoration of disturbed areas shall be performed following the conclusion of a project or activity. All temporary excavations shall be filled in, contoured, and vegetated to restore as closely as possible the existing condition of the site(s). Construction shall be blended into the surrounding landscape and vegetated. Local or California native plant species shall be used. All trash, especially food-related items, shall be deposited in closed containers or bags and removed from the site daily.

(9) Toxic Chemicals

Use of toxic chemicals such as rodenticide and herbicides shall be in strict accordance with Federal, State, local, and Army regulations. Government approval is required for any pesticide use by the contractor or any of his subcontractors.

(10) Project Briefing

Project or activity supervisors will be briefed on environmental and conservation procedures prior to commencement. The briefing will include information on endangered species and other environmental concerns and conservation measures. Supervisors will then be responsible for dissemination of this information to the project or activity personnel, and implantation of the procedures discussed.

(11) Encounters

Anyone encountering dead, injured, or trapped animal shall immediately notify their supervisor. The supervisor shall in turn notify the appropriate government representative. The following guidelines shall be observed:

a. Trapped animals: Cease activity in the immediate vicinity. Provide a ramp or other means of escape if practicable. ADO NOT attempt to grasp or hold a wild animal.

b. Injured animals): DO NOT ATTEMPT TO HANDLE THE ANIMAL! Note the type and severity of injury if possible, the location and the time the animal was found. Notify SATCOM personnel at (805) 238-8675.

c. Dead animals: DO not touch or move the carcass, and avoid disturbing the area around the carcass. Mark the location and notify SATCOM personnel at (805) 238-8675.

(12) Additional Requirements

a. No pets will be allowed on Camp Roberts or the SATCOM facility at any time.

b. Firearms are prohibited.

c. The contractor supervisors shall attend a one hour workshop on environmental and conservation procedures by the Government. The briefing shall include information on endangered species and other environment

concerns and conservation measures. Supervisors shall then be responsible for dissemination of this information to the project tor activity personnel, and implementation of the procedures discussed.

d. Contractor shall use a wildlife biologist approved by the U.S. Fish and Wildlife Service and follow all requirements for the following: U.S. Fish and Wildlife Service, 1989, standardized recommendation for protection of the San Joaquin Kit Fox, April 1989; endangered Species Office, Sacramento, CA.

***** CALIFORNIA AND NEVADA DESERT AREAS (EDWARDS, IRWIN, NELLIS, GEORGE, ETC.) *****

1.3.5 Protection of Endangered Trees:

(A) Endangered Trees within Project Site:

Due to the limited vegetation in the area, removal or relocation of plants shall be minimized. The Contractor shall obtain approval from the Contracting Officer before removing or relocating any endangered plants within the construction boundaries. One such plant is the Joshua Tree which is an endangered species. How to identify this tree and procedures for relocating those within the project site, are described as follows:

(B) Joshua Trees:

Only trees under 5 feet tall shall be moved using hand tools. Mark North side of the tree and plant in same orientation. Using shovel, dig down to get main root mass (generally within 2 feet of surface). Try to get tap root and a fibrous water storage structure that it leads to. Take some of the soil to put in new hole. Roots should be dusted with sulfur to prevent rot. A small amount of manure can be mixed in with soil when replanting. Soil should be tamped down and a small berm placed around plant 5-foot diameter. Water with several gallons. Stake in 2 directions to prevent wind from knocking down. If not transplanted right away, "heel in" the plant (lay them on their side and cover roots with soil). Very large Joshua Trees (10-20 feet tall) shall not be moved but be detoured around by the utilities. If plants need relocation areas, they can be used in landscaping around the base.

***** ALL PROJECTS AT YUMA PROVING GROUND, AZ.*****

1.3.5 Storm Water Pollution Prevention Plan:

Submit a Storm Water Pollution Prevention Plan. A sample of the basic part of the plan is attached at the end of this section (Attachment No. 1). Revise the sample plan or prepare a new plan by incorporating project specific data, and provide details as required and submit with the completed Notice of Intent to the Contracting Officer or his representative for approval. The two Notices, Government and Contractor, will be sent by the Government to the EPA. Update the Plan as necessary during construction and provide copies of the update to the Government.

1.4 AIR RESOURCES

***** INSERT TITLE OF APPROPRIATE STATE RULES IF ANY. REMOVE LAST SENTENCE WHEN NOT A JOB REQUIREMENT *****

Equipment operation and activities or processes performed by the Contractor

in accomplishing the specified construction shall be in accordance with the State's [_____] rules and all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained. Monitoring of air quality shall be the Contractor's responsibility. All air areas affected by the construction activities shall be monitored by the Contractor. Monitoring results will be periodically reviewed by the Government to ensure compliance.

1.4.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

***** OPTION DDRW SHARPE & TRACY *****

1.4.1.1 Dust Control

An acceptable plan for dust control including prevention of generation of dust due to operation, construction handling, equipment parking area (Example: Water Sprinkling) must be developed prior to the start of work. Reference SJUAPCD rules on fugitive dust.

1.4.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

1.4.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

1.4.4 Sound Intrusions

***** INSERT STATE'S NAME OR REMOVE LAST SENTENCE WHEN STATE RULES ARE NOT APPLICABLE.*****

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the [_____] rules.

***** VANDENBERG *****

1.4.4 Noise Pollution:

The Contractor shall maintain all noise levels within the following limits and regulations:

(A) All vehicles shall have operational noise suppression systems (e.g. mufflers).

(B) Noise levels shall comply with OSHA Standards for the State Model Community Noise Control Ordinance.

(C) Construction operations which generate excessive noise levels shall be prohibited between the hours of 7:00 P.M. and 7:00 A.M. without prior approval by the Contracting Officer.

***** VANDENBERG *****

1.4.5 Emission Control:

The Contractor shall see that all his vehicles and stationary piston-engine-powered equipment have emission control systems in conformance with Federal, State, and local regulations, as specified in 40 CFR 60 and 40 CFR 85-86 (and later amendments); in the California Administrative Code, Title 17, Part III, and Title 13, Chapter 3 (and later amendments); and in the rules and regulations of the Santa Barbara County Air Pollution Control District. These emission control systems shall be operational and well maintained at all times. In addition, transfer and storage systems that carry or contain volatile liquids or solids or that generate particulates shall be constructed and operated to minimize escape of vapors and particulates and shall comply in this regard with regulations of the U.S. Environmental Protection Agency, the State of California, and the Santa Barbara County Air Pollution Control District.

***** VANDENBERG *****

1.4.6 Maintenance of Pollution Control Facilities During Construction:

During the construction period the Contractor shall conduct adequate training courses for his supervisory maintenance personnel (down to and including foreman) including initial instructions of at least 30 minutes and continuing instruction at appropriate times but in no case less than 30 minutes per month. The curriculum shall include but not be limited to the following topics:

(A) Methods of detection and avoiding pollution;

(B) Familiarity with environmental standards both statutory and contractual;

(C) Installation and care of vegetation covers, plants, and other facilities to prevent and correct environmental pollution.

(D) Instruction in the recognition of archaeological resources.

***** FOR SOUTHERN CALIFORNIA ONLY, EXCEPT VANDENBERG (SUCH AS MARCH, IRWIN, ETC.) CHECK TECH SECTION FOR PAVEMENT MARKINGS AND PAINTING - CHECK WITH TM *****

1.4.7 South Coast Air Quality Management District Permits:

(A) Paint and coatings spray application equipment requires a written permit to operate from the South Coast Air Quality Management District (SCAQMD) if more than one gallon of oil base or 3 gallons of waterborne coatings are applied in a single day. Also, the coatings must comply with the volume limits in SCAQMD Rule 1113.

(B) Sandblasting equipment requires a permit from SCAQMD and must comply with conditions of SCAQMD Rule 1140.

***** DELETE INAPPROPRIATE SECTIONS *****

1.5 WASTE DISPOSAL

Disposal of wastes shall be as specified in Section [02120 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS] [02050 DEMOLITION] [_____] and as specified below.

1.5.1 Solid Wastes

***** REMOVE NON-APPLICABLE BRACKETED OPTION *****

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste. [The Contractor shall transport solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.] [Waste materials shall be hauled to the Government landfill site [shown on the drawings] [designated by the Contracting Officer]. The Contractor shall comply with [site procedures] [Federal, State, and local laws and regulations] pertaining to the use of landfill areas.]

1.5.2 Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 150 mm (6 inches) of the top. Wastes shall be disposed of in accordance with Federal and local laws and regulations.

1.5.3 Hazardous Wastes

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. The Contractor shall transport hazardous waste off Government property and dispose of it in compliance with Federal and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the Contractor's responsibility.

***** SIERRA ONLY *****

1.5.3.1 Oil or Fuel Spill Control:

The Contractor shall provide an acceptable plan for preventing the

generation of an uncontrolled oil or fuel discharge on the depot. This plan should consist of the containment and clean-up procedures. Storage of oil or fuel shall be in a lined, bermed area capable of containing the volume of material stored.

1.5.4 Burning Rubbish and Debris:

Open burning of rubbish, debris and other combustibles will not be permitted on the ********Base *****Post *****Depot*****Presidio *****Fort *****Site***.

1.6 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

*****

1.7 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction.

1.8 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore landscape features damaged or destroyed during construction operations outside the limits of the approved work areas.

1.9 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

1.10 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental pollution control.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

-- End of Section --

*****YUMA PROVING GROUND - THIS ATTACHMENT SHALL BE INSERTED AT THE END OF SECTION 01410 WHEN PARAGRAPH 1.3.5 IS USED. THIS ATTACHMENT SHALL BE USED WITHOUT EDITING. COPIES OF ENCLOSURES ARE LOCATED IN THE BIN.*****

S A M P L E

STORM WATER POLLUTION PREVENTION PLAN

(TITLE OF PROJECT)

YUMA PROVING GROUND, ARIZONA

STORM WATER POLLUTION PREVENTION PLAN
YUMA PROVING GROUND, ARIZONA

The US Army Corps of Engineers will be responsible for construction of the project facilities. Upon completion of construction, the facilities' ownership, operation and maintenance will be turned over to US Yuma Proving Ground, Yuma, Arizona.

1. **Objectives**

This Storm Water Pollution Prevention Plan (SWPPP) has been prepared in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) Arizona General Permit for Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity. The regulatory authority: Environmental Protection Agency (EPA) Region IX.

This SWPPP has been developed and will be amended, if necessary, to meet the following objectives:

(a) To identify, construct, and implement storm water control structures and pollution prevention measures (control practices) to reduce pollutants in storm water discharges from the construction site both during construction and after construction is completed.

2. **Implementation Schedule**

Currently, construction activities for this project are expected to commence __(Date)___. Project completion is planned for __(Date)_____.

3. **Availability**

The SWPPP will be kept on-site during construction activity and made available upon request of EPA or local agency.

4. **Required changes**

This SWPPP will be amended if there is any change in construction or operations which may affect the discharge of significant quantities of pollutants to surface waters, ground waters, or municipal separate storm drain system. The SWPPP will also be amended if it is in violation of any condition of the Arizona General Construction Activity Storm Water Permit or has not achieved the general objective of reducing pollutants in storm water discharges.

5. **Source Identification**

(a) Water flows from the Muggins Mountains, across the Castle Dome Plain (where the project is located), into the Castle Dome Wash and into the Gila River. The project is situated on the Arroyo between two drainage channels.

Enclosure 1 is a map showing the construction site for the ____(Project title and PN number)_____, general topography and general anticipated discharge locations from the construction site.

(b) Enclosure 2 is a site map for the facility showing the following information:

I. Location of Control Practices Used During Construction (There are no separate control facilities required during construction).

ii. Areas of cut and fill.

iii. Drainage pattern and slopes anticipated after major grading

activities are completed.

iv. Areas of soil disturbance

v. Areas of potential soil erosion where control practices will be used. (There are no separate control facilities during construction.)

vi. Existing and planned paved areas and buildings.

vii. Location of post-construction control practices (There are no required post-construction control practices.)

viii. Vehicle storage and service areas (No vehicle storage and service area has been identified. The plan leaves it up to the Contractor to find a suitable place for these activities that will meet the requirements of this permit. The Contractor is to submit this location before proceeding with construction. Once this submittal has been approved, it will be included in the SWPPP.)

(c) I. No toxic materials are known to have been treated, stored, disposed, spilled or leaked onto the construction site. Antipersonnel mines and small arms munitions may be located under the surface. A surface clearance of the area has been completed.

ii. The Contractor shall detail measures to be taken to avoid pollution of surface or groundwater bodies with fuel, oils, greases, chemicals, waste washing, vehicle washing, herbicides, insecticides, cement, or other harmful materials. The description shall be attached as a part of the SWPPP.

iii. No material loading, unloading, and access areas have been identified. The plans leave it up to the Contractor to find a suitable place for these activities that will meet the requirements of this permit. The Contractor is to submit this location before proceeding with construction. Once this submittal has been approved, it will be attached to the SWPPP.

iv. There are no separate pre-construction control facilities required for sediment control.

v. No equipment storage, cleaning and maintenance areas have been identified. The plans leave it up to the Contractor to find a suitable place for these activities that will meet the requirements of this permit. The Contractor is to submit this location before proceeding with construction. Once this submittal has been approved, it will be attached to the SWPPP.

vi. Prior to initiation of construction the Contractor shall detail how construction materials are to be stored and disposed of to meet the requirements of this permit.

vii. Fill material will be taken from the site shown on the drawings and will also be brought in from an outside source. Prior to construction, the Contractor must submit the source of any borrow material brought in from an outside source for approval. Upon approval of this submittal, this SWPPP will be revised to reflect this new information.

(d) No pollution other than sediment is likely to be present in storm water discharge from the construction site.

(e) The size of the ___(project title)___, required rights-of-way, and access roads are approximately _(20 acres)_.

6. **Soil Stabilization Practices**

There are few existing trees or shrubs in the construction area. The area has little rainfall, see Enclosure 3. The specifications require the Contractor, except in the areas to be cleared for the actual facilities are indicated, to preserve the land in it's existing condition. Any landscape feature scarred or damaged by the Contractor shall be restored as closely as possible to its original condition. Upon completion of construction, the Contractor shall obliterate all signs of temporary construction facilities such as work areas, structures, stockpiles of excess material, or any other vestiges of construction. The disturbed areas will be restored to as near natural conditions as possible. As there is insufficient rainfall to support vegetation, the areas disturbed should be compacted or a thin layer of gravel be placed to prevent erosion. Prior to commencement of work the Contractor is required to submit in writing his proposal for implementing these requirements of the SWPPP.

(a) Practices to control sediment load in storm water discharge from the construction site: No special control practices are required at this time. The soil classification and potential for erosion by the soil conservation service are provided in Enclosure 4. A majority of the soil is classified as cristobal-Gunsight with moderately slow to moderate permeability with hazard of water/wind erosion slight. If the Contractor determines that to meet the requirement of this permit, control facilities are required, this SWPPP will be amended accordingly.

(b) Practice to reduce tracking of sediment into public and private roads: The amount of sediment that would be tracked onto roads that would then result in runoff into surface water would not be significant, therefore, no special measures will be taken.

(c) Control practices to reduce wind erosion: The specifications require the Contractor to maintain all excavations, embankments, stockpiles, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries, free from dust which would cause the local standards to be exceeded. Prior to commencement of work the Contractor is required to submit in writing his proposal for implementing this requirement of the SWPPP. Approved temporary methods of stabilization for dust control consist of sprinkling, chemical treatment or similar method.

7. **Non-storm Water Management**

No discharge of materials other than storm water to surface or ground water bodies is allowed. Prior to initiation of construction the Contractor shall submit a plan detailing measures to be taken to avoid pollution of surface or groundwater bodies with fuels, oils, bituminous materials, greases, acids, calcium chloride, chemicals, waste washings, vehicle washings, herbicides, insecticides, cement, or other industrial materials, Upon approval of this plan, it shall be attached as a pert of this SWPPP.

8. **Post-Construction Storm Water Management**

Any landscape feature scarred or damaged by the Contractor shall be restored as closely as possible to its original condition. Therefore, post-construction conditions will be the same as pre-construction conditions as far as potential for sediment loads from storm water discharges. Upon completion of construction, the Contractor shall obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, stockpiles of excess materials, or any other vestiges of construction. The disturbed areas will be restored to as near natural conditions as possible.

Therefore, post-construction conditions will be the same as pre-construction conditions as far as potential for sediment loads from storm water discharges. No post-construction sediment control practices are required.

9. **Waste Management and Disposal**

Prior to initiation of construction the Contractor shall submit a plan detailing how all waste materials are to be disposed of to be in compliance with Federal, State, and local laws, regulations, and ordinances. Once this plan has been approved, it shall be attached as a part of this SWPPP.

10. **Training**

During construction the Contractor is required to conduct training courses for his supervisory personnel monthly covering at least the following topics:

(a) Methods of detection and avoiding pollution

(b) Familiarity with environmental standards, both statutory and contractual.

Prior to initiation of construction the Contractor shall submit a plan detailing this training for approval. Once this plan has been approved, it shall attached as part of this SWPPP.

11. **Monitoring and Inspections**

The Contractor shall be required to meet the conditions of the monitoring program including the requirement to inspect the construction site prior to anticipated storm events and after actual storm events to identify areas contributing to a storm water discharge associated with construction activity and to evaluate whether measures to reduce pollutant loadings identified in this SWPPP are adequate and properly implemented, or whether additional control measures are needed. These inspections are to be done by trained personnel. Prior to initiation of construction the Contractor shall submit a plan detailing how this requirement is to be accomplished. Once this plan has been approved, it shall be attached as a part of the SWPPP. (See sample at end of section)

12. **List of Contractor/subcontractors**

The prime Contractor has not been selected.

13. **Other Plans**

The contract documents specify the requirements of the Contractor as outlined in this SWPPP.

14. **Public Access**

Upon request by members of EPA Region 9, this SWPPP will be made available for review. The regulation in accordance with Section 308(6) of the Clean Water Act.

15. **Oil and Hazardous Substance Liability**

Nothing in this plan shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharge is or maybe subject under section 311 of the Clean Water Act.

16. **Required Certification and Signatory**

Certification:

"I certify under penalty of law that this document and all attachments were

prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

_____
(Signature of Construction
Company Official)

Enclosures:
1. Enclosure 1 - Vicinity Map (Ref para 5(a))
2. Enclosure 2 - Site Map (Ref para 5(b))
3. Enclosure 3 - Precipitation bar charts (Ref para 6)
4. Enclosure 4 - References from the Yuma PG Soil Survey (Ref para 6(a))

STORM WATER POLLUTION PREVENTION PLAN

INSPECTION AND MAINTENANCE REPORT FORM

TO BE COMPLETED EVERY 7 DAYS AND
WITHIN 24 HOURS OF A RAINFALL EVENT

INSPECTOR:_____ DATE:_____

INSPECTOR'S QUALIFICATIONS:

_____

_____

_____

_____

DAYS SINCE LAST RAINFALL:_____ AMOUNT OF LAST RAINFALL _____ INCHES

STABILIZATION MEASURES

AREA	DATE SINCE LAST DISTURBED	DATE OF NEXT DISTURBANCE	STABILIZED? (YES/NO)	STABILIZED WITH	CONDITION

STABILIZATION REQUIRED:

_____

_____

_____

_____

TO BE PERFORMED BY: _____ ON OR BEFORE: _____

* * * * *

INDEX

SECTION 01451

CONTRACTOR QUALITY CONTROL

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SECTION 01440

CONTRACTOR QUALITY CONTROL

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	(1994a) 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

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

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 which 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. The project superintendent 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 project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 10 calendar 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, test, 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 feature 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.

3.2.2 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following 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 the project superintendent.

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 which 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.

3.2.3 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.

3.2.4 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 General

Minimum requirements for the CQC organization are a CQC System Manager and the specified number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a CQC organization which 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 acceptance by the Contracting Officer.

3.4.2 CQC System Manager

The Contractor shall identify as CQC System Manager an individual within his organization at the site of the work 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 shall be a graduate engineer, graduate architect, or a graduate of construction management, with a minimum of 3 years construction experience on Corps of Engineers construction projects similar to this contract. This CQC System Manager shall be on the site at all times during construction and will be employed by the prime Contractor. The CQC System Manager shall be assigned no other duties. An alternate for the CQC System Manager will be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate will be the same as for the designated CQC System Manager, except for the Corps of Engineers experience.

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 civil/architectural. These individuals shall be directly employed by the prime Contractor; 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 experience in accordance with the experience matrix listed herein. These individuals shall have no other duties other than quality control.

Experience Matrix

Area	Qualifications
a. Civil/Architectural (All other specification sections)	**Graduate** Civil Engineer or Graduate Architect with 2 years experience in the type of work being performed on this project
b. Mechanical (15000 specification sections)	Graduate Mechanical Engineer with 2 yrs experience in the type of work being performed on this project
c. Electrical (16000 specification sections)	**Graduate** Electrical Engineer with 2 yrs related experience in the type of work being performed on this project

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". This course is offered quarterly by the Los Angeles District, contact the Contracting Officer for more information.

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

Submittals shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals 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 each paragraph of applicable specifications.

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 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 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 a 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 48 hours 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. 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 On-site 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.

3.7.4 Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials will be borneby the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to the QA laboratory designated by the Contracting Officer.

Coordination for each specific test, exact delivery location and dates will be made through the Area Office.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Special Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and 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 this 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 thereof 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 this 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 should be identified (Preparatory, Initial, Follow-up). List 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. Submittals reviewed, with contract reference, by whom, and action taken.

g. Off-site surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

i. Instructions given/received and conflicts in plans and/or specifications.

j. 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, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no work period. 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 IMPLEMENTATION OF GOVERNMENT RESIDENT MANAGEMENT SYSTEM FOR CONTRACTOR QUALITY CONTROL OF CONTRACT

The Contractor shall utilize a Government furnished CQC Programming Module (A computerized executable file which is DOS based and operates on a minimum of 80386 IBM compatible computers). During the course of the contract, the

CQC Programming Module will become Windows based. The minimum hardware requirements will be a Pentium Pro 200+ Processor, 256KB cache, 64MB RAM, and 5.0GB hard drive. The Contractor shall include the change to a windows based system in their bid. The Module includes a Daily CQC Reporting System form which must also be used. This form may be in addition to other Contractor desired reporting forms. However, all other such reporting forms shall be consolidated into this one Government specified Daily CQC Report Form. The Contractor will also be required to complete Government-Furnished Module elements which includes, but is not limited to, Prime Contractor staffing; letter codes; planned cumulative progress earnings; subcontractor information showing trade, name, address, point-of-contact, and insurance expiration dates; definable features of work; pay activity and activity information; required Quality Control tests tied to individual activities; planned User Schooling tied to specific specification paragraphs and contractor activities; Installed Property Listing, Transfer Property Listing and submittal information relating to specification section, description, activity number, review period and expected procurement period. The sum of all activity values shall equal the contract amount, and all Bid Items, Options and Additives shall be separately identified, in accordance with the "Pricing Schedule". Bid Items may include multiple Activities, but Activities may only be assigned to one such Bid Item. This Module shall be completed to the satisfaction of the Contracting Officer prior to any contract payment (except for Bonds, Insurance and/or Mobilization, as approved by the Contracting Officer) and shall be updated as required. The CQC Programming Module requires an HP Laserjet printer as a minimum.

(1) During the course of the contract, the Contractor will receive various Quality Assurance comments from the Government that will reflect corrections needed to Contractor activities or reflect outstanding or future items needing the attention of the Contractor. The Contractor will acknowledge receipt of these comments by specific number reference on his Daily CQC Report, and will also reflect on his Daily CQC Report when these items are specifically completed or corrected to permit Government verification.

(2) The Contractor's schedule system shall include, as specific and separate activities, all Preparatory Phase Meetings (inspections); all O&M Manuals; and all Test Plans of Electrical and Mechanical Equipment or Systems that require validation testing or instructions to Government representatives.

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.

3.12 CONSTRUCTION CONTROL MANUAL

In addition to the requirements specified in the various Technical Specifications hereinafter, test procedures and minimum number of tests will be performed in accordance with SPK PAM 415-1-2, "Construction Control Manual". Neither the specified minimum number of tests nor the lack of them shall in any way limit or relieve the Contractor of his responsibility to perform adequate tests to assure compliance with the quality requirements of these specifications. The referenced standards listed in this Construction Control Manual shall be of the latest issue unless otherwise specified.

The "Construction Control Manual" may be examined in the following office locations, and will be furnished to the Contractor:

Corps of Engineers Los Angeles District Construction Management Section 911 Wilshire Blvd. Los Angeles, California	Corps of Engineers Vandenberg Resident Office, Building M11452 1174 Iceland Avenue Vandenberg AFB, California

-- End of Section --

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SECTION 01500

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SECTION 01500

TEMPORARY CONSTRUCTION FACILITIES

PART 1 GENERAL

1.1 APPLICABLE PUBLICATIONS:

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.

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1983) Construction and Industrial Plywood
DOC PS 20	(1970) American Softwood Lumber Standard.

FEDERAL SPECIFICATIONS (FS)

FS TT-E-2784	(Rev A) Enamel, Acrylic-Emulsion

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z535.1	(1991) Safety Color Code

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

U.S. ARMY CORPS OF ENGINEERS

EM 385-1-1	Safety and Health Requirements Manual (3 September 1996).

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 16	(1970; Rev 1983) Standard Grading and Dressing Rules for Douglas Fir, Western Hemlock, Western Red Cedar, White Fir, Sitka Spruce Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01	(1991; Supple No. 1) Western Lumber Grading Rules 91

1.2 GENERAL REQUIREMENTS

1.2.1 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, avenues of ingress/egress to the fenced area and details of the fence installation. Any areas which may have to be graveled to prevent the tracking of mud shall also be identified.

1.2.2 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.

1.2.3 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 military installation.

1.3 AVAILABILITY AND USE OF UTILITY SERVICES

1.3.1 Payment for Utility Services

The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The Contractor shall carefully conserve any utilities furnished without charge. The Contractor's attention is directed to Section 00800, Paragraph AVAILABILITY OF UTILITIES SERVICES.

1.3.2 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.

1.3.3 Telephone

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

1.4 BULLETIN BOARD, PROJECT SIGN, AND PROJECT SAFETY SIGN

1.4.1 Bulletin Board

Immediately upon beginning of work, the Contractor shall provide a weatherproof glass-covered bulletin board not less than 915 by 1220 mm (36 by 48 inches) in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer. Legible copies of the aforementioned data shall be displayed until work is completed. Upon completion of work the bulletin board shall be removed by and remain the property of the Contractor.

1.4.2 Project and Safety Signs

(A) General:

The Contractor shall construct and erect one project sign, one safety sign and a minimum of 6 hard hat signs at locations designated by the Contracting Officer. The signs shall conform to the requirements of the drawings attached at the end of this section. The signs shall be erected as soon as possible and within 15 days after date of commencement of work under this contract. The data required by the safety sign shall be corrected daily.

(B) Materials:

(1) Lumber shall conform to DOC PS 20 and grading rules of applicable grading agencies, WCLIB or WWPA. Grade shall be "Standard" or better Douglas Fir, S4S and shall be stamped S-Dry.

(2) Plywood: Plywood shall conform to DOC PS 1, Grade AC, Group 1, Exterior.

(3) Bolts, Nuts and Nails: Bolts and nuts shall be galvanized, and type, and size best suited for intended for use. Nails shall conform to ASTM F 547.

(4) Paint: Type of paint for primer, finish coats, and lettering, shall be as indicated on the attached standard drawing. The color of signs and lettering shall be as directed by the Contracting Officer. Safety signs shall be painted in the same colors as the project sign. Hard hat signs shall be painted as indicated on the attached drawing.

(5) Decals: Corps of Engineers castle decal and the hard hat decal called for on the signs will be furnished by the Government.

(C) Construction:

(1) Signs shall be constructed as detailed on attached drawings.

(2) Painting: All exposed surfaces and edges of plywood shall be given one coat of linseed oil and be wiped prior to applying primer. All exposed surfaces of signs and supports shall be given one coat of primer and one finish coat as indicated. All lettering shall be sized as indicated. Width of letter stroke shall be 1/6 of the letter height, except as noted.

(D) Maintenance and Disposal:

The Contractor shall maintain the signs in good condition throughout the life of the project. Signs shall remain the property of the Contractor and upon completion of the project they shall be removed from the site.

1.5 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 flagmen, 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.

1.5.1 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, although optional, 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.

1.5.2 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.

1.6 CONTRACTOR'S TEMPORARY FACILITIES

1.6.1 Administrative Field Offices

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. Within the Contractor’s administrative field office facilities, office space shall be provided for the Government. The office space shall consist of the following:

An enclosed room with lockable door (approximately 10 feet square)
Desk and chair
Plan table
Telephone with base line

1.6.2 Storage Area

The Contractor shall construct a temporary 1.8 meter (6 foot) high chain link fence around trailers and materials. The fence shall include plastic strip inserts, colored brown, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Trailers, materials, or equipment shall not be placed or stored outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the military boundaries. Trailers, equipment, or materials shall not 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.

1.6.3 Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but shall be within the military boundaries. Fencing of materials or equipment will be required at this site. The Contractor shall be responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities may be provided to this area by the Government.

1.6.4 Appearance of Trailers

Trailers utilized by the Contractor for administrative or material storage purposes shall present a clean and neat exterior appearance and shall be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on the military property.

1.6.5 Maintenance of Storage Area

Fencing shall be kept in a state of good repair and proper alignment. Should the Contractor elect to traverse with construction equipment or other vehicles grassed or unpaved areas which are not established roadways, such areas shall be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways; gravel gradation shall be at the Contractor's discretion. Grass located within the boundaries of the construction site shall be mowed 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.

1.6.6 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 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor shall install a satisfactory means of communication, such as telephone or other suitable devices. The devices shall be made available for use by Government personnel.

1.8 HOUSEKEEPING AND CLEANUP:

Pursuant to the requirements of paragraph, CLEANING UP and paragraph, ACCIDENT PREVENTION, of the CONTRACT CLAUSES, Section 00700, the Contractor shall assign sufficient personnel to insure strict compliance. The Contractor shall submit a detailed written plan for implementation of this requirement. The plan will be presented as part of the preconstruction safety plan and will provide for keeping the total construction site, structures and accessways free of debris and obstructions at all times. Work will not be allowed in those areas that, in the opinion of the Contracting Officer's representative, have unsatisfactory cleanup and housekeeping at the end of the preceding day's normal work shift. At least once each day all areas shall be checked by the Quality Control person of the Prime Contractor and the findings recorded on the Quality Control Daily Report. In addition, the Quality Control person will take immediate action to insure compliance with this requirement. Housekeeping and cleanup shall be assigned by the Contractor to specific personnel. The name(s) of the personnel shall be available at the project site; each person will be supplied with a distinctively marked hard hat, to be worn from the beginning to the end of the project.

1.9 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.

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SECTION 01505

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SECTION 01505

GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SCRAP MATERIAL:

Materials specified to be removed and become the property of the Contractor are designated as scrap, and the Contractor, by signing this contract, hereby acknowledges that he has made due allowance for value, if any, of such scrap in the contract price.

1.2 WRITTEN GUARANTEES AND GUARANTOR'S LOCAL REPRESENTATIVE:

Prior to completion of the contract, the Contractor shall obtain and furnish to the Contracting Officer's representative written guarantees for all the equipment and/or appliances furnished under the contract. The Contractor shall furnish with each guarantee: The name, address, and telephone number of the guarantor's representative nearest to the location where the equipment and/or appliances are installed, who, upon request of the Using Service's representative, will honor the guarantee during the guaranty period and will provide the services prescribed by the terms of the guarantee.

1.3 PRICING OF CONTRACTOR-FURNISHED PROPERTY:

At the request of the Contracting Officer, the Contractor shall promptly furnish and shall cause any subcontractors to furnish, in like manner, unit prices and descriptive data required by the Government for property record purposes of fixtures and equipment furnished and installed by the Contractor.

1.4 TEMPORARY ELECTRIC WIRING:

(A) Temporary Power and Lighting:

The Contractor shall provide construction power facilities in accordance with the safety requirements of the National Electrical Code NFPA No. 70 and the SAFETY AND HEALTH REQUIREMENTS MANUAL EM 385-1-1. The Contractor, or his delegated subcontractor, shall enforce all the safety requirements of electrical extensions for the work of all subcontractors. All work shall be accomplished by skilled electrical tradesmen in a workmanlike manner, as approved by the Contracting Officer.

(B) Construction Equipment:

In addition to the requirements of EM 385-1-1, SAFETY AND HEALTH REQUIREMENTS MANUAL, all temporary wiring conductors installed for operation of construction tools and equipment shall be either Type TW or THW contained

in metal raceways, or may be multiconductor cord. Temporary wiring shall be secured above the ground or floor in a workmanlike manner and shall not present an obstacle to persons or equipment. Open wiring may only be used outside of buildings, and then only in strict accordance with the provisions of the National Electrical Code.

(C) Circuit Protection:

In addition to the present requirements in EM 385-1-1 and the National Electrical Code, all 15 and 20-ampere receptacle outlets used for obtaining power during construction shall have ground fault circuit interrupters (GFCI) for personnel protection. Block and brick saws shall also be equipped with GFCI. The Contracting Officer may allow an exception to this requirement for circuits for concrete vibrators or circuits operating at other than 60 Hertz normal (in both cases an assured grounding program as described in the National Electrical Code, except utilizing the daily inspection frequency of the grounding means of such equipment, may be permitted). The assured grounding program will not be permitted as a substitute for usage of GFCI'S except as described above. All generator-powered 15- and 20-ampere, 60 Hertz receptacle outlets shall have GFCI'S, and shall be properly grounded. A testing means shall be provided which will impose a measured fault of 5 milliamperes, plus or minus 1 milliamperes, and result in tripping the GFCI unit.

1.5 UTILITIES NOT SHOWN:

If the Contractor encounters, within the construction limits of the entire project, utilities not shown on the plans and not visible as to the date of this contract and such utilities will interfere with construction operations, he shall immediately notify the Contracting Officer in writing to enable a determination by the Contracting Officer as to the necessity for removal or relocation. If such utilities are removed or relocated as directed by the Contracting Officer, the Contractor shall be entitled to equitable adjustment for any additional pertinent work or delay.

1.6 GENERAL SAFETY REQUIREMENTS:

(A) General:

The Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, (see Contract Clauses, Section 00700, ACCIDENT PREVENTION) and the Occupational Safety and Health Act (OSHA) Standards for Construction (Title 29, Code of Federal Regulations Part 1926 as revised from time to time); General Industry Standards (Title 29, Code of Federal Regulations Part 1910 as revised from time to time); and the National Fire Protection Association Codes are applicable to this contract. In case of conflict the most stringent requirement of the standards is applicable. Prior to start of construction, the Contractor shall submit a Site Specific Safety Plan to the Contracting Officer for approval (reference EM 385-1-1, Paragraph 01.A.05 and Appendix A.)

(B) The Prime Contractor's superintendent

The Prime Contractor's superintendent shall take an active role in enforcing the safety requirements by participation in safety conferences, hazard analysis (see below), tool box meetings, walk-through inspections, correction of violations, etc., and including that of the subcontractor's work.

(C) Job Hazard Analysis:

Based on the construction schedule, the Contractor shall submit a job hazard analysis of each major phase of work prior to entering that phase of activity. The analysis shall include major or high risk hazards, as well as commonly recurring deficiencies that might possibly be encountered for that operation, and shall identify proposed methods and techniques of accomplishing each phase in a safe manner. The Prime Contractor's superintendent shall take active participation in the Job Hazard Analysis, including the subcontractors' work. Prior to start of actual work a meeting shall be held with Prime Contractor, Government, and affected subcontractor to review the Job Hazard Analysis. In addition, job site meetings shall be held to indoctrinate foreman and workers on details of this analysis.

(D) Violations:

If recurring violations and/or gross violation indicate that the safety performance is unsatisfactory, corrective action shall be taken as directed, and at the discretion of the Contracting Officer the retention or some part thereof will be withheld from the progress payment until corrective action has been completed.

(E) Elevated Work Areas:

Workers in elevated work areas in excess of 6 feet above an adjoining surface require special safety attention. In addition to the provisions of EM 385-1-1, the following safety measures are required to be submitted to the Contracting Officer's Representative. Prior to commencement of work in elevated work areas, the Contractor shall submit drawings depicting all provisions of his positive protection system including, but not limited to, all details of guard rails.

(1) Positive protection for workmen engaged in the installation of structural steel and steel joists shall be provided by safety nets, tie-off's, hydraulic man lifts, scaffolds, or other required means. Decking crews must be tied-off or work over nets or platforms not over 6 feet below the work area. Walking on beams and/or girders and the climbing of columns is prohibited without positive protection.

(2) Perimeter guard rails shall be installed at floor, roof, or wall openings more than 6 feet above an adjoining surface and on roof perimeters. Rails shall be designed to protect all phases of elevated work including, but not limited to, roofing operations and installation of gutters and flashing. Rails around roofs may not be removed until all work on the roof is complete and all traffic on or across the roof ceases. Rails shall be designed by a licensed engineer to provide adequate stability under any anticipated impact loading. As a minimum, the rails shall consist of a top rail at a height of 42 inches, a mid rail and a toe board. Use of tie-offs, hydraulic man lifts, scaffolds, or other means of roof edge protection methods may be utilized on small structures such as family housing, prefabricated metal buildings, etc.

(F) Fire Prevention:

Twenty-four hours notice shall be given to the Contracting Officer for coordination with the Facility Fire Department prior to conducting any fire hazardous operation. Cutting or welding will be permitted only in areas that are or have been made fire safe. Where possible, all combustibles shall be located at least 35 feet horizontally from the work site. Where such location is impracticable, combustibles shall be protected with fire blankets and/or protective welding screens to prevent slag from running out of the work area. Edges of covers at the floor shall be tight to prevent sparks from going under them. This precaution is also important at overlaps where several covers are used to protect a large pile. Other fire prevention precautions shall be in accordance with the latest National Fire Codes.

(1) The Contractor shall obtain certification by calling the Base Fire Department Dispatch Center at ext. 6-5380 or 6-5971. Please give the following information:

Facility Number _____
Hot Work Permit Number _____
Name of Person Calling _____
Name of Contractor _____

(2) Contractor shall observe all safety and fire regulations as presently enforced at Vandenberg AFB. The construction shall be in accordance with the Corps of Engineers' Manual, General Safety Requirements EM 385-1-1, and Occupational Safety and Health Act (OSHA) Public Law 91-596. Comply with OSHA and Air Force Occupational Safety and Health (AFOSH) safety standards.

(3) All construction sites are subject to fire and safety inspections without notice. Any violation of fire and safety standards may result in a work stoppage at the expense of the Contractor.

(G) Recordkeeping/Reporting Requirements:

On all contract operations, the Prime Contractor shall be responsible for recording and reporting all accident exposure and experience incident work. (This includes exposure and experience of the prime contractor and his/her sub-contractor(s)). As a minimum these records shall include exposure work-hours and a log of occupational injuries and illnesses. (OSHA Form 200 or state equivalent as prescribed by 29 CFR 1904.5) Reference EM 385-1-1, 02.A.02.

(H) Accident Reporting:

In addition to the requirements for reporting accidents in accordance with EM 385-1-1, Section 1, the Prime Contractor will submit at the 50% point and 100% of project completion, a written summary of worker's compensation claims filed by workers on the project. The report will include all subcontractors. The main report covering the Prime Contractor claims will be certified as "correct and true" by the Contractor's compensation insurance carrier. The same certification will be required for subcontractor reports.

1.7 PLANNED UTILITY OUTAGES

Utility outages shall be restricted to off-duty hours and weekends (5:00 p.m. to 7:00 a.m.) with the outage duration not to exceed 4 hours. All outages shall be scheduled as far in advance as possible with the Contracting Officer and in no case less than 14 days before the outage. The Contractor shall obtain in writing from the Contracting Officer a statement or schedule giving the permissible times of utility outages for particular installations. The Contractor shall strictly observe such schedules and will be held responsible for any violations.

1.8 PERMITS:

(A) Excavation Permit:

(1) The Contractor shall obtain and process an AF Form 103, Civil Engineering Work Clearance Request, from the Contracts Management Section, Building 11433, 6-8093. The Contractor shall provide sketches showing the location, size, and depth of any excavation and trenching. The Contractor shall list proposed utility, fire, or security system outages. The AF Form 103 shall be processed through the appropriate government agencies for review and coordination. Government agencies will annotate the form with special instructions or requirements. The AF Form 103 with sketches, all in triplicate, shall be submitted a minimum of 5 work days prior to the proposed construction start date. Work shall not begin until the AF Form 103 is fully approved.

(2) When any digging is performed in the vicinity of utilities or communication cables, Civil Engineering Group (30 CEG) and/or Communications

Squadron (30 CS) monitors, as required, will be present. No mechanical digging shall be performed within 4 feet of utilities or communication cables until they are physically exposed by hand digging. If a utility or communication cable is damaged, notify the Contracting Officer immediately. Twenty-four hours advance notice for CE monitors, 6-8093, and CS monitors, 6-4400, is required. Work shall not begin until the monitors are present.

(3) Seventy-two hours advance notice for environmental monitors, 6-1922, is required. Work shall not begin until the monitors are present.

(B) Welding Permit:

Welding or torching of any kind on Vandenberg AFB requires a welding permit. The Contractor shall obtain a welding permit from the Fire Protection Flight, Building 10660, 6-5380. A permit will be issued within 2 work days with instructions for welding fire prevention.

1.9 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER:

(A) This provision specifies the procedure for the determination of time extensions for unusually severe weather in accordance with the CONTRACT CLAUSE, Section 00700, 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:

(1) 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.

(2) 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.

(B) 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
(05)	(05)	(05)	(03)	(01)	(00)	(00)	(00)	(01)	(01)	(04)	(05)

(C) Upon acknowledgment of the Notice to Proceed (NTP) 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. (ER 415-1-15, 31 OCT 89)

1.10 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE

(A) 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 VII. 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.

(B) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36 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 leasees are allowable. Costs for major repairs or overhaul are unallowable.

(C) 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 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.

1.11 SPECIAL CONSTRUCTION/SECURITY PROCEDURES:

(A) Security

(1) The Contractor shall be responsible at their own cost for obtaining the services of any security escorts required for access to, or work in or adjacent to, existing secure areas/facilities/zones.

(2) Base-wide identification of employees

The Contractor shall submit the following information on its company letterhead not less than 7 calendar days prior to the start of work on this project.

(a) Project Name

(b) Project Location
(c) Project start date
(d) Anticipated completion date

(e) Name and social security number of each employee who will be working on this project.

(f) Registration numbers of all vehicles that will be required to enter the Base.

(B) Use or travel of vehicle or heavy equipment on location outside the project limits shown on the drawings is prohibited.

(C) Internal combustion engines:

All internal combustion engines other than engines equipped with turbochargers or pollution control catalytic converters, which are operated in off-road conditions, shall be equipped with U.S. Forest Service approved spark arresters.

(D) Use of fire hydrants

Any use of the fire hydrants will be coordinated one week in advance with the base fire department and airfield management.

(E) Cooperation with Others:

During the life of this contract, other Contractors will be performing operations in the general area where work under this contract is being performed. The Contractor shall cooperate with others in all respects wherever necessary for the better prosecution of the work. As far as practicable, all persons working in the vicinity shall have equal rights to the use of all transportation facilities and grounds within the limitations specified in the CONTRACT CLAUSES, Section 00700. The obligation of the Contractor under this contract shall include jointly planning and scheduling the work, on a cooperative basis, with other Contractors in order to minimize delays and interferences. The Contractor shall so arrange his operations as to not interfere with other work in progress. In case of dispute or disagreement regarding use of transportation and storage facilities and rights of access, the decision of the Contracting Officer shall govern.

(F) The Contractor shall supply a copy, including any subsequent revisions, of his construction schedule, to the Contracting Officer (who will supply information to the facility user to adjust their operations), as soon as possible after Notice to Proceed.

(G) The Contractor shall obtain a demolition permit from Santa Barbara Air Pollution Control District, prior to starting demolition work on existing facilities or construction.

(H) The Contractor will process necessary Pacific Gas and Electric Company paperwork for rebates to the Government, on energy efficient lighting and equipment used in the new facility. Coordination will be through the Contracting Officer and the Base Civil Engineering Office.

(I) Payment for Off-Site Materials

Irregardless of other contract clauses, payment shall not be made for material stored off-site.

(J) Payment for On-Site Material

Payment for equipment/material stored on site shall be subject to the following conditions:

(1) Equipment/material shall be properly stored

(2) Contractor must prove ownership by providing a copy of the PAID invoice for the equipment/material.

(3) Payment for equipment/material shall be made only for that portion scheduled to be incorporated into the project within 90 calendar days following the receipt of the request for payment.

1.12 LABOR RATES

Within 30 calendar days of receipt of Notice to Proceed, the Contractor shall furnish to the Contracting Officer a listing of all labor rates anticipated to be used on the project. The labor rates shall be listed by work category (e.g., carpenter, electrician, plumber, etc.) as well as skill level (e.g., apprentice, foreman, journeyman, etc.). The labor rates shall be broken down by basic hourly rate, hourly fringe rate, and labor burden. The labor burden shall be sufficiently detailed to permit verification by the Contracting Officer. The listing shall distinguish between workers whose fringes are paid in to an approved plan versus workers whose fringes are paid directly. The listing shall be accompanied by a statement signed by a company official certifying the labor rates listed are accurate and the labor burden detailed is indeed being incurred.

1.13 WEEKLY COORDINATION MEETING

The Contractor shall participate in weekly coordination meetings with representatives of the Contracting Officer and Government. The Contractor shall be responsible for preparing the agenda, distributing the agenda, conducting the meeting, preparing the minutes, distributing the minutes, and tracking action items. Typical topics shall consist of: review of previous week’s activities and progress; forecast of following week’s activities and progress, in particular any utility outages; pending transmittals; late transmittals; pending modifications; anticipated modifications; and any other concerns/ and/or issues. As a minimum, the Contractor shall have in attendance their on-site manager (project engineer, manager, or superintendent), QC manager, and scheduler.

1.14 MANDATORY WORK STOPPAGES

(A) A mandatory work stoppage occurs whenever the Contractor is restricted from working a full workday and is unable to reallocate work forces to other locations. All costs associated with ten (10) mandatory work stoppages must be included in the bid price. No additional compensation or extension to the Contract performance period will be given as a result of ten (10) mandatory work stoppages.

(1) In the event that the Contractor's work force is required to evacuate any part of the working area during working hours established by the Contractor for this contract, the Government will then make an adjustment under the clause entitled, FAR 52.212-12 SUSPENSION OF WORK, see Section 00700. The Government's liability will be considered to be limited to reimbursement for loss of time of Contractor's employees and equipment which otherwise would have been employed on the job. The completion time for any part of the work will not be extended if the total number of working hours of work stoppage does not exceed 0.8 times the number of calendar days in the period between the date of notice to proceed and the specified completion date. In the event the Contractor is required to evacuate the area in excess of the time specified above, the completion times will be adjusted.

(B) The Contractor may be required, without advance notice, to move work to a different location. The Contractor shall be prepared to increase or decrease his work forces with appropriate trades to perform work in the relocated work areas at no additional cost to the Government.

(C) The Contractor shall notify the Contracting Officer when a mandatory work stoppage occurs for recording purposes. Otherwise, the work stoppage will not be credited to the Contractor.

1.15 RADIOACTIVE MATERIAL CONTRACT STATEMENT

(A) Prior to any operations using radioactive material, operators will ensure the following is given to the Base Radiation Safety Officer (BRSO)(30 AMDS/SGPB;6-7811) for review and approval at least two weeks prior to operations.

(1) A copy of a valid and current USAF Permit, for Air Force users; or a copy of a valid and current Nuclear Regulatory Commission License or Agreement State License with Nuclear Regulatory Commission Form 241, for non-Air Force users.

(2) A copy of a valid and current Radiation Safety Program.

(3) A copy of a valid and current Emergency Response Information.

(4) Operating parameters, including:

a. Radioisotope

b. Activity

c. Time of Operation

d. Date of Operation

e. Location of Operation

f. Contractor/Subcontractor Name

g. Contractor Point of Contact (POC) and phone number; and USAF POC and phone number.

(B) Operators are required to have the following on hand while operating:

(1) A copy of a valid and current USAF Permit, for Air Force users; or a copy of a valid and current Nuclear Regulatory Commission License or Agreement State License with Nuclear Regulatory Commission Form 241, for non-Air Force users.

(2) A copy of a valid and current Radiation Safety Program.

(3) A copy of a valid and current Emergency Response Information.

(4) A copy of Nuclear Regulatory Commission Form 3.

(5) A copy of documents required by 10 CFR 19, *Notices, Instruction and Reports to Workers: Inspection and Investigations,* paragraph 11, *Posting of Notices to Workers.*

(6) A visible 2 mR/hr line must be established prior to operation, to ensure safety of Air Force personnel and assets.

(C) Strict adherence to 10 CFR 19, *Notices, Instruction and Reports to Workers: Inspection and Investigations;* 10 CFR 20, *Standards for Protection Against Radiation;* and 10 CFR 21, *Reporting of Defects and Noncompliance;* and Air Force Instruction 40-201, *Managing Radioactive Material in the USAF,* is required while operating on Vandenberg AFB, CA. The Base Radiation Safety Officer (30 AMDS/SGPB), or his designee, may conduct unannounced on-site visits to ensure established radiation safety practices are being conducted.

(D) Additional requirements exist for operations other than industrial radiography, soil densitometry, etc; for example, irradiators (10 CFR 36) and well-logging (10 CFR 39). Consult BRSO for specific requirements for operators using irradiators or performing well-logging for at least four weeks prior to operation.

NOTE: If Department of Energy sources are used, certification of exemption from Nuclear Regulatory Commission licensing requirements is required prior to operations. When moving Radioactive Material on Vandenberg AFB, CA, contact personnel according to Radioactive Material Tracking Checklist.

Vandenberg AFB, CA Radioactive Material Tracking Checklist

	Prior to Coming on Base	Moves in Base Boundaries	Transfers From One Permittee/ Licensee To another	Launched	Prior to Leaving Base
Permitted AF Radioactive Material, 30 SW	contact B/P/U RSO	contact U RSO	contact B/P/U RSO	contact B/P/U RSO	contact B/P/U RSO
Permitted AF Radioactive Material, other than 30 SW	contact B/P/U RSO	contact U RSO	contact B/P/U RSO	contact B/P/U RSO	contact B/P/U RSO
AF Contractor	contact B/P RSO	contact P RSO	contact B/P RSO		contact B/P RSO
Army/Navy/DoD Component	contact B/P RSO	contact B RSO	contact B/P RSO		contact B/P RSO
NASA contact	contact B/P RSO	contact P RSO	B/P RSO	contact	B/P RSO

NASA Contractor	contact B/P RSO	contact P RSO	contact B/P RSO		contact B/P RSO
Department of Energy Licensed Radioactive Material	contact B/P RSO	contact P RSO	contact B/P RSO		contact B/P RSO
Department of Energy non-Licensed Radioactive Material	contact B/U RSO	contact B/U RSO	contact B/U RSO	contact B/U RSO	contact B/U RSO

NOTES:

B RSO = Base Radiation Safety Officer -- 30 AMDS/SGPB, 6-7811
P RSO = Permit Radiation Safety Officer -- Each permit has its own P RSO
U RSO = Unit Radiation Safety Officer -- Each unit has its own U RSO

1.16 DISPOSAL OF REMOVED MATERIALS

(A) The Government inspector will examine all materials removed from the project not indicated for reuse, and will tag or otherwise designate those materials which are serviceable or salvable.

(B) Serviceable or salvageable items, except for locks, latches, and cylinders, shall be turned in, by appointment, to the base Defense Reutilization and Marketing Office (DRMO) or Base Supply by the Contractor. All locks, latches, and cylinders shall be turned in to the Base Lockshop. The Contractor shall schedule DRMO appointments far enough in advance to allow efficient processing of turn-ins. Scrap metal shall be segregated into ferrous and nonferrous metals, and shall be cut, dismantled, palletized, or prepared as required by the DRMO office for acceptance. Dismantling of equipment or material into separate components may be required. The Contractor shall protect materials from damage or theft during the interval between removal and disposal. Any serviceable or salvageable items not accepted by DRMO or Base Supply, for whatever reason, will become the property of the Contractor and will be properly handled, transported, and be disposed of off-base by the Contractor in conformance with all federal, state, and local regulations. See Section 01130 for disposal of hazardous materials.

(C) Unusable items (with no salvage value) shall be **disposed of off base.**

Vehicles used in transporting refuse shall have a tarpaulin or covering to prevent spillage.

See Section 01410 for disposal of hazardous materials.

1.17 CONTRACTOR SAFETY PERSONNEL REQUIREMENTS: (1985 JAN HQ USACE)

(A) Full-time, on-site, safety coverage by contractors shall be required for the life of the contract.

(B) The following conditions shall be met:

(1) The Contractor shall employ, to cover all hours of work at the project site(s), at least one safety and health person to manage the Contractor's safety program; duties which are not germane to the safety program shall not be assigned to this person(s). The principal safety and health person shall report to and work directly for the Contractor's top on-site manager, corporate safety office, or other high-level official of equivalent position. The safety and health person(s) shall have the authority to take immediate steps to correct unsafe or unhealthful conditions. The employment of a safety and health person(s) shall not abrogate the safety and health responsibilities of other personnel.

(2) Qualifications for Safety and Health Person(s).

(a) Safety and Health Person(s) shall have a degree in engineering or safety in at least a four year program from an accredited school and shall have been engaged in safety and occupational health for at least one (1) year of experience (no time being credited to this one (1) year unless at least fifty (50) percent of the time was devoted to safety and occupational health) and shall have at least one (1) year experience in construction, or--

(b) Safety and Health Person(s) shall have legal registration as a Professional Engineer or a Certified Safety Professional and shall have been engaged in safety and occupational health for at least one (1) year of experience (no time being credited to this one (1) year unless at least fifty (50) percent of the time was devoted to safety and occupational health) and shall have at least one (1) year experience in construction, or--

(c) Safety and Health Person(s) shall have a degree other than that specified in paragraph, Qualifications for Safety and Health Person(s) above, and shall have been engaged in safety and occupational health for at least three (3) years of experience (no time being credited to these three (3) years unless at least fifty (50) percent of the time each year was devoted to safety and occupational health) and shall have at least two (2) years experience in construction, or--

(d) In lieu of a degree, Safety and Health person(s) shall have been engaged in safety and occupational health for at least five (5) years of experience (no time being credited to these five (5) years unless at least fifty (50) percent of the time each year was devoted to safety and occupational health) and shall have at least two (2) years experience in construction.

(e) First aid work is not a creditable experience.

(3) The name and qualifications of the nominated safety and health person(s) shall be furnished to the Contracting Officer for acceptability and a functional description of duties shall be provided prior to the pre-work conference.

NOTE: The Contractor shall have one or more Safety and Health Persons, each of whom meets the qualifications of (B)(2) Qualifications for Safety and Health Person(s), physically present on the actual site of the work whenever work of any sort is being performed by a Contractor, subcontractor, or supplier personnel on the work site. The foregoing clause language shall not be interpreted to contravene this note.

1.18 MONTHLY SAFETY INSPECTION:

A monthly on-site inspection will be made by the insurance carriers of the prime and subcontractors. The Contractor's safety program will be reviewed and a meeting will be held with the Contracting Officer's Representative to discuss the job-site safety. A written report will be made by the Contractor stating the results of the inspection and the action taken.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

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SECTION 02050

DEMOLITION

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)

EM 385-1-1	(1992) U.S. Army Corps of Engineers Safety and Health Requirements Manual

1.2 GENERAL REQUIREMENTS

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; salvaged items and materials shall be disposed of as specified.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Work Plan; FIO.

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.

1.4 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to

avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding and pollution.

1.5 PROTECTION

1.5.1 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.

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, may be allowed to remain standing without additional bracing, shoring, of lateral support until demolished. 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.

1.5.2 Protection of Existing Property

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.

1.5.3 Protection From the Weather

The interior of buildings to remain and salvageable materials and equipment shall be protected from the weather at all times.

1.5.4 Protection of 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 1.83 m (6 foot) high fence. The fence shall be securely erected a minimum of 1.5 m 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.

1.5.5 Environmental Protection

The work shall comply with the requirements of Section 01410.

1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.7 USE OF EXPLOSIVES

Use of explosives will be permitted.

1.8 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available after the IQT Facility is complete and accepted.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXISTING STRUCTURES

Existing structures indicated shall be removed to grade. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

3.2 UTILITIES

Disconnection of utility services, with related meters and equipment, are specified in Section 02685. Existing utilities shall be removed as indicated. 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.

3.3 FILLING

Holes and other hazardous openings shall be filled in accordance with Section 02221.

3.4 DISPOSITION OF MATERIAL

Title to material and equipment to be demolished, except Government salvage items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Salvageable Items and Material

Contractor shall salvage items and material to the maximum extent possible.

3.4.1.1 Material Salvaged for the Contractor

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.

3.4.1.2 Items Salvaged for the Government

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 by the Contracting Officer.

3.4.2 Unsalvageable Material

Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of as indicated by the Contracting Officer.

3.5 CLEAN UP

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.

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SECTION 02210

GRADING

PART 1 GENERAL

1.1 SCOPE OF WORK

This Section specifies rough grading and compaction for the site and building pad(s) along with the final grading and finishing for paved areas and open or landscaped areas. This Section also specifies remediation measures for expected unstable conditions on the construction site. Finished grading for the project building(s) is specified in Section 02221 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS. All utility earthwork is specified under Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2487	(1992;R 1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2573	Field Vane Shear Test in Cohesive Soil
ASTM D 3740	(1992) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1984) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5268	(1992)Topsoil Used for Landscaping Purposes
ASTM D 5255	(1992)Certification of Personnel Engaged in the Testing of Soil and Rock

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

EM 1110-2-1906	Laboratory Soils Testing
EM 1110-2-1907	Soils Sampling
EM 385-1-1	Safety and Health Requirements Manual
CESPK PAM 415-1-2	Construction Control Manual

1.3 UNIT PRICE

1.3.1 MEASUREMENT

1.3.1.1 Excess Overexcavation and Replacement of Unstable Materials

The unit of measurement for excess overexcavation and replacement of unstable materials will be the cubic meter, computed by the average end-area method from cross sections taken before and after the excess overexcavation and replacement operations. The amount paid for will be the number of cubic meters of material, measured in its original position and removed by excess overexcavation as defined herein after. The measurement will include the replacement of unstable material with properly compacted and tested satisfactory materials up to the grade of overexcavation shown on the Contract Drawings. The measurement will not include the amount excavated without authorization or the amount of any material used for other than directed purposes. The measurement will not include the amount of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.3.2 PAYMENT

1.3.2.1 Excess Overexcavation and Replacement of Unstable Materials

Excavation will be paid for at the contract unit price per cubic meter for the optional bid item "Excess Overexcavation and Replacement".

1.3.2.2 Bridging Material

Bridging materials will be paid for at the contract unit price per cubic meter for the optional bid item "Bridging Material".

1.4 DEFINITIONS

1.4.1 Excess Overexcavation

Excess overexcavation shall be defined as any excavation below the required overexcavation grades shown in the Contract Drawings. Compensation shall only be authorized for the excess overexcavation of materials defined as unstable materials as defined herein after and measured as specified herein before.

1.4.2 Satisfactory Materials

Materials classified in ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, CL and combinations of these such as SP-SM are satisfactory for fill and backfill on this project. Materials shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 50 mm. Additionally, the percent passing the No. 40 standard sieve shall

have a liquid limit of no greater than 35 when tested in accordance with ASTM D 4318.

1.4.2.1 Bridging Materials

Bridging materials are only satisfactory for stabilizing unstable areas that are to be paved once written authorization is obtained from the Contracting Officer. Bridging materials shall consist of hard and durable well graded cobble and gravel sized materials. Authorization, quantities, and compensation shall be agreed to prior to material delivery to the site.

1.4.3 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as CH, MH, Pt, OH, and OL are unsatisfactory. Man-made fills and backfills of otherwise satisfactory materials from previous construction are unsatisfactory until compacted to the densities specified herein. Any materials that are unstable and will not readily compact to the densities specified herein are unstable and unsatisfactory. Rubble from previous construction encountered during cut operations shall be removed from the site and disposed of off base.

1.4.3.1 Unstable Materials

Unstable material may be encountered at this site during construction. Materials that cannot be properly compacted or will not support construction equipment due to excessive moisture are unstable. Potentially unstable materials are fine grained soils with moisture contents near or above the plastic limit or 5 or more percent above the ASTM D 1557 optimum water content. Inplace materials with a shear strength of less than 100 kN/square meter when tested in accordance with ASTM D 2573are to be considered unstable under this Contract. Unstable material will require disking and drying and/or replacement and disposal. Bridging of unstable materials in areas to be paved may be performed with the authorization of the Contracting Officer.

1.4.4 Degree of Compaction

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Procedure C, abbreviated herein after as a percent of laboratory maximum dry density.

1.4.5 Topsoil

Materials obtained from offsite areas and surface excavations, suitable for landscaping and planting, are defined as topsoil. Topsoil shall meet the requirements outlined in ASTM D 5268.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-08 Statements

Field Testing Control; FIO.

Qualifications of the commercial testing laboratory who will be performing all testing in accordance with paragraph FIELD TESTING CONTROL.

SD-09 Reports

Field Testing Control; FIO. Satisfactory Materials; FIO.

Certified test reports and analysis certifying that the satisfactory materials proposed for use at the project site conform to the specified requirements, and for all tests conducted in accordance with paragraph FIELD TESTING CONTROL.

1.6 SUBSURFACE DATA

Subsurface soil boring and backhoe trench logs are shown on the drawings. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

PART 2 PRODUCTS

2.1 BORROW MATERIAL

Borrow materials shall meet the requirements for satisfactory materials and selected to meet requirements and conditions of the particular fill for which it is to be used. Necessary clearing, grubbing, disposal of debris, and satisfactory drainage of borrow pits shall be performed by the Contractor as incidental operations to the borrow excavation. Borrow materials shall be tested in conformance with ASTM D 2487 and shall meet the following general requirements:

Sieve Size	Percent Passing by Weight
50 mm	100
4.75 mm	30-90
75 um	0-35

Liquid Limit of less than 35
Plasticity Index of less than 12

2.1.1 Selection

Borrow materials shall be obtained from sources outside the limits of Government-controlled land and shall be subject to approval. Borrow materials shall be subject to approval. The source of borrow material shall be the Contractor's responsibility. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, shall pay all royalties and other charges involved, and shall bear all the expense of developing the sources, including rights-of-way for hauling.

2.1.2 Borrow Pits

Except as otherwise permitted, borrow pits shall be excavated to afford adequate drainage. Overburden and other spoil material shall be disposed of or used for special purposes. Borrow pits shall be neatly trimmed after the excavation is completed.

PART 3 EXECUTION

3.1 TOPSOIL

Onsite surface materials shall be considered unsatisfactory for reuse as topsoil. For estimation purposes, topsoil and turf materials will need to be imported from offsite sources. The surface shall be completely cleared of vegetation and surface debris to a minimum depth of 100 mm prior to grading operations.

3.2 EXCAVATION

After surface clearing has been completed, excavation of every description, regardless of material encountered, within the grading limits of the project shall be performed to the lines and grades indicated. Satisfactory excavation material shall only be transported to and placed in fill areas after potholing operations and excess overexcavation and replacement operations are completed. All unsatisfactory material including any soil which is disturbed by the Contractor's operations or softened due to exposure to the elements and water and surplus material shall be removed from site. All excess soil materials shall be removed from Government-controlled land, at the Contractor's expense, prior to the completion of construction, unless otherwise directed by the Contracting Officer. Excavations carried below the depths indicated, without specific directions, shall be refilled to the proper grade with properly compacted satisfactory material at the Contractor's expense. Excavation and filling shall be performed in a manner and sequence that will provide drainage at all times. All excavations shall be kept free from water while construction therein is in progress. No additional compensation shall be forthcoming for the excavation and replacement of materials rendered unsatisfactory by Contractor managed operations. Satisfactory material required for fills in excess of that produced by excavation within the grading limits shall be obtained from borrow areas.

3.2.1 Potholing

After cut operations have been completed and prior to the commencement of fill operations, the building area shall be "potholed" to determine the depth and extent of unstable materials. The subsurface materials shall be tested in accordance with ASTM D 2573 to determine the extend of unstable materials. The potholes shall be left in an open condition while the Contractor and the Contracting Officer determine the cubic meters of material for excess overexcavation and replacement. Unstable material removal and replacement beyond the overexcavation depths indicated shall be compensated for as specified herein before. Potholes shall be kept free of water; no additional compensation shall be forthcoming for the excess overexcavation and replacement of additional materials rendered unsatisfactory by Contractor managed operations.

3.3 DITCHES, GUTTERS, AND CHANNEL CHANGES

Ditches, gutters, and channel changes shall be cut accurately to the cross sections and grades indicated. All roots, stumps, rock, and foreign matter in the sides and bottom of ditches, gutters, and channel changes shall be removed to conform to the slope, grade, and shape of the section indicated. Care shall be taken not to excavate ditches and gutters below the grades indicated. Excessive ditch and gutter excavation shall be backfilled to grade either with satisfactory, thoroughly compacted material. All ditches and gutters excavated under this section shall be maintained until final

acceptance of the work. Satisfactory material excavated from ditches and channel changes may be placed in fill areas. Unsatisfactory and excess excavated material shall be disposed of in accordance with directions in paragraph EXCAVATION. No excavated material shall be deposited closer to the edges of the ditches than indicated and in no case less than 1 meter.

3.4 BACKFILL ADJACENT TO STRUCTURES

Backfill adjacent to structures shall be placed and compacted uniformly in such manner as to prevent wedging action or eccentric loading upon or against the structures. Slopes bounding or within areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. During backfilling operations and in the formation of embankments, equipment that will overload the structure in passing over and compacting these fills shall not be used. Backfill for storm drains and subdrains, including the bedding and backfill for structures other than culverts and drains, shall conform to the additional requirements in other applicable sections.

3.5 PREPARATION OF GROUND FOR FILL

All vegetation, debris, and unstable material within the area upon which fill is to be placed, shall be stripped or overexcavated and replaced before the fill is started. In no case will unstable material remain in the subgrade of the fill area. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped, or broken up, as directed, in such manner that the fill material will bond with the existing surface. Prepared surfaces on which compacted fill is to be placed shall be wetted or dried as may be required to obtain the specified moisture content and density.

3.6 FILLS AND EMBANKMENTS

Fills and embankments shall be constructed at the locations and to lines, grades, and elevations indicated. Satisfactory material obtained during excavation may be used in forming required fill. Fills shall be constructed of satisfactory material free from roots and other organic material, and trash. The material shall be placed in successive horizontal layers of 200 mm in loose depth for the full width of the cross section and shall be compacted as specified. Each layer shall be compacted and tested before the overlaying lift is placed. Moisture content of the fill or backfill material shall be adjusted by wetting or aerating, as required, to within plus or minus 2 percent of optimum moisture content as determined from laboratory tests specified in paragraph DEFINITIONS.

3.7 COMPACTION

Each layer of the fill or embankment for open and landscaped areas and areas to be paved shall be compacted to at least 90 percent of laboratory maximum dry density. The upper 150mm of paved area subgrades shall be compacted to a minimum of 93 percent of the laboratory maximum dry density. Building pad fill and backfill shall be compacted to at least 95 percent of the laboratory maximum dry density. Materials shall be compacted at a water content within 2 percent of optimum.

3.8 FINISHED EXCAVATION, FILLS, AND EMBANKMENTS

All areas covered by the project, including excavated and filled sections and adjacent transition areas, shall be uniformly smooth-graded. The finished surface shall be smooth, compacted, and free from irregular

surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations, except as otherwise specified. Ditches and gutters shall be finished to permit adequate drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials. For subgrade areas to be paved, the following shall be accomplished as required: (a) unstable and otherwise unsatisfactory native material shall be removed or bridged; (b) low areas resulting from removal of unstable material brought up to required grade with satisfactory material compacted to a minimum of 90 percent of the maximum dry density, (c) a minimum 150 mm subgrade layer of satisfactory material shall be placed and compacted to a minimum of 93 percent of the maximum dry density, full depth. The entire subgrade shall be shaped to the required line, grade, and cross section. The surface of building pads and paved areas on which a base course is to be placed shall vary not more than 15 mm from the established grade and approved cross section. Other surfaces shall be finished not more than 30 mm above or below the established grade or approved cross section.

3.9 PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 50 mm depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 75 mm and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil shall be obtained from areas off of Government-controlled land.

3.10 FIELD TESTING CONTROL

Testing shall be the responsibility of the Contractor and shall be performed by an approved commercial testing laboratory subject to approval and meeting the requirements specified in ASTM D 3740. Testing personnel shall meet the requirement outlined in ASTM D 5255. Information shall be submitted on a "Test Log" which shall include but not be limited to the following, as applicable: test type, test date, test number, feature of work, station/location, offset, elevation, shear strength, inplace dry unit weight, moisture content, percent compaction, pass or fail, test method, and soil classification.

3.10.1 Potholing

No additional compensation shall be forthcoming for potholing operations. No additional compensation shall be forthcoming for the backfilling of pothole excavation into stable materials. Potholing shall be performed at 25 square meter intervals in the areas assumed to have unstable materials. Potholing shall continue until the areas, perimeters, and depths of unstable materials are defined. Potholes shall be excavated through stable surface materials to the bottom of the unstable zones. Potholes shall be left open for inspection by the Contracting Officer for the purpose of determining the quantity of excess overexcavation and backfilling to be performed. The Contracting Officer may order deeper excavation or more potholing if unstable areas are not clearly defined.

3.10.2 Shear Strength

Shear strength testing of inplace materials shall used to differentiate stable materials from unstable materials. Shear strength shall be determined with the vane shear apparatus specified in ASTM D 2573. The "AX" casing size from Table-1 with a vane diameter of 38.1 mm shall be

used. Testing shall be sufficient to accurately determine if the pothole is completely stable or to what depth excess overexcavation will be required to remedy unstable conditions in the area.

3.10.3 Field Density with Moisture Content

Field in-place density shall be determined in accordance with ASTM D 1556. **Nuclear gage testing is not allowed**.

3.10.4 Moisture-Density Relationships

Moisture-density relationships shall be determined by the test method outlined in ASTM D 1557, Procedure C.

3.10.5 Gradations, Atterberg Limits, and Classification

Gradation testing for soil materials shall be performed in accordance with ASTM D 422. Atterberg limits shall be determined by ASTM D 4318. Classification shall be determined by the test methods outlined ASTM D 2487.

3.10.6 Testing Schedule

Testing shall be as follows:

(a) Field Density with Moisture Content: For area fills and backfills, perform two tests per each increment or fraction of 1000 square meters placed during each 8 hour shift.

(b) Gradation with Atterberg Limits: From compacted material; one test for every 5 field density tests.

(c) Moisture-Density Relationship with Gradations, Atterberg Limits, and Classification: From a bulk sample; one set of tests for every 5 field density tests (with not less than one test for each type of material) for the first 25 field density tests. Thereafter, one additional test for each change in material.

3.11 PROTECTION

Newly graded areas shall be protected from traffic and from erosion, and any settlement or washing away that may occur from any cause, prior to acceptance, shall be repaired and grades reestablished to the required elevations and slopes. All work shall be conducted in accordance with the environmental protection requirements of the contract.

-- End of Section --

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SECTION 02221

EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS

PART 1 GENERAL

1.1 SCOPE OF WORK

This section specifies final earthwork for building foundations and slabs-on-grade, with the exception of the underground utility earthwork in building areas, which is specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. **Unstable conditions are expected at this site**; remediation of unstable materials under the building pad area is specified in Section 02210 GRADING.

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 CONCRETE INSTITUTE

ACI 229R	(1994) Controlled Low Strength Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 131	(1989) Resistance to Degradation of Small -Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1993) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1992;R 1993) Classification of Soils for Engineering Purposes (Unified Soil

	Classification System)
ASTM D 3740	(1992) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1984) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5255	(1992)Certification of Personnel Engaged in the Testing of Soil and Rock

1.3 DEFINITIONS

1.3.1 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 Procedure C, abbreviated herein after as percent laboratory maximum dry density.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-09 Reports

Field Density Tests; GA. Testing of Backfill Materials; GA.

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

Materials classified in ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, CL and combinations of these such as SP-SM are satisfactory for use on this project. Materials shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 50 mm. The portion passing the No. 40 standard sieve shall have a liquid limit of no greater than 35 when tested in accordance with ASTM D 4318.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as CH, MH, Pt, OH, and OL are unsatisfactory. Man-made fills and backfills of otherwise satisfactory materials from previous construction are unsatisfactory until compacted to the densities specified herein. Any materials that will not readily compact to the densities specified herein are unstable and unsatisfactory.

2.1.2.1 Unstable Materials

Materials that cannot be properly compacted or will not support construction equipment due to excessive moisture are unstable. Unstable material remediation is specified under Section 02210 GRADING. No additional compensation for remediation of unstable materials shall be forthcoming for the work included under this Section.

2.2 CAPILLARY WATER BARRIER MATERIAL

Capillary water barrier material shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. Capillary water barrier material shall be graded to meet the requirements for size 57 or 67 concrete coarse aggregate as specified in ASTM C 33.

2.3 SAND

Sand shall conform to ASTM C 33 requirements for concrete fine aggregate. Additionally, sand shall have a water content of less than 7 percent as determined by ASTM D 2216 when placed.

2.4 CONTROLLED LOW STRENGTH MATERIAL

Controlled low strength material (CLSM) shall meet the requirements specified in ACI 229R and shall consist of a lean concrete slurry of type II portland cement blended with size 7 concrete coarse rounded aggregate conforming to the requirements specified in ASTM C 33. Controlled low strength material shall have a 28-day compressive strength of between 345 and 690 kPa when tested in accordance with ASTM C 39.

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

Clearing and grubbing operations shall be completed during grading operations. The areas within lines 1.5 m outside of each building and structure line shall be cleared and grubbed of trees, stumps, roots, brush and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with satisfactory material, placed and compacted in accordance with paragraph FILLING AND BACKFILLING. Materials removed shall be disposed of outside the limits of Government-controlled property at the Contractor's responsibility.

3.2 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified herein after, and shall include trenching for utility and foundation drainage systems to a point 1.5 m beyond the building line and all work incidental thereto. Trenching for utilities is specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. 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 replaced with properly compacted satisfactory material. No additional

compensation shall be forthcoming for the excavation and replacement of unsatisfactory materials. Satisfactory material removed below the depths indicated without specific direction of the Contracting Officer shall be replaced at no additional cost to the Government, to the indicated excavation grade, with satisfactory materials. 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.

3.3 DRAINAGE AND DEWATERING

3.3.1 Drainage

Surface water shall be directed away from excavation and construction sites so as 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 and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained. No additional compensation shall be forthcoming for the removal and replacement of materials rendered unsatisfactory because of the Contractor's failure to adequately drain the site.

3.3.2 Dewatering

Groundwater and water from broken utility lines that flow 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 900 mm 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. No additional compensation shall be forthcoming for the removal and replacement of materials rendered unsatisfactory because of the Contractor's failure to adequately dewater excavations.

3.4 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. No additional compensation shall be forthcoming for shoring.

3.5 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered. No additional compensation shall be forthcoming for the removal of rock or cemented soil materials.

3.6 BLASTING

Blasting will not be permitted.

3.7 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be

excavated as specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Trenches shall be excavated to the required alignment, depth, and slope.

3.8 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained Section 02210 GRADING.

3.9 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 02210 GRADING.

3.10 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

All foundation excavations shall be inspected and approved by the Contracting Officer prior to the placement of reinforcing steel and again immediately prior to the placement of foundation concrete. No steel or concrete shall be placed in excavations that contain unstable material, standing water, debris, or loose material. The bottoms of foundation excavations shall be protected as required with a 100 mm layer of controlled low strength material during inclement conditions, until the foundation concrete is poured.

3.11 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive backfill, or upon which the capillary water barrier is to be placed, shall be removed and replaced with satisfactory materials. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

3.12 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing backfills to the lines and grades indicated and for replacing unsatisfactory materials. Satisfactory materials shall be placed in horizontal layers not exceeding 200 mm in loose thickness, or 150 mm when hand-operated compactors are used. 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 not be placed in wet or unstable areas. 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 100 mm 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 dry density specified below:

	Percent Laboratory maximum dry density
Fill, embankment, and backfill	
Under structures, building slabs, steps, paved areas, around footings, and in trenches, full depth	95
Under sidewalks and grassed areas, full depth	90
Subgrade	
Under building slabs, steps, and paved areas, upper 300 mm minimum or full depth of fill	95
Under sidewalks, upper 150 mm or full depth of fill	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. No additional compensation shall be forthcoming for subgrade correction measures. Recompaction over underground utilities and heating lines shall be by hand tamping only.

3.13 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 subject to approval and meeting the requirements specified in ASTM D 3740. Testing personnel shall meet the requirements outlined in ASTM D 5255. Information shall be submitted on a "Density Test Log" which shall include but not be limited to the following: test date, test number, feature of work, station/location, offset, elevation, inplace dry unit weight, moisture content, percent compaction, pass or fail, test method, and soil classification.

3.13.1 In-Place Densities

Field in-place density shall be determined in accordance with ASTM D 1556. Nuclear gage testing will not be allowed.

3.13.2 Moisture-Density Relationship with Gradation, Atterberg Limits, Specific Gravity, and Classification

Moisture-density relationships shall be determined by the test method outlined in ASTM D 1557, Procedure C.

3.13.3 Gradation, Atterberg Limits, and Classification

Gradation testing of aggregates shall be performed by the test method outlined in ASTM C 136. Gradation testing for soil materials shall be performed in accordance with ASTM D 422. Atterberg limits shall be determined by ASTM D 4318. Classification shall be determined by the test method outlined in ASTM D 2487.

3.13.4 Miscellaneous Testing

Wear tests for capillary water barrier material and controlled low-strength material aggregate shall be performed in accordance with ASTM C 131. Aggregates shall have a loss of no greater than 40 percent when tested with 500 revolutions. A minimum of two compressive strength tests shall be in accordance with ASTM C 39 for each source of controlled low strength material. Sieve size analysis for capillary water barrier material, sand, and controlled low-strength material aggregate shall be performed in accordance with ASTM C 136.

3.13.5 Testing Schedule

The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

(a) Field Density and Moisture Content: For wall footings and utility trenches, perform one test for each lift or each increment or fraction of 60 meters. For isolated column footings, one random test during backfilling operations at each footing location.

(b) Moisture-Density Relationship with Gradation, Atterberg Limits, and Classification: From a bulk sample; one set of tests for every 5 field density tests (with not less than 1 test for each type of material) for the first 25 field density tests. Thereafter, one additional test for each change in material.

(c) Miscellaneous Granular Materials: For capillary water barrier material and controlled low-strength material aggregate; perform a minimum of two random sieve size analyses and two wear tests for each material source. Perform a minimum of two sieve size analyses and two water content tests for inplace sand as the vapor barrier cushion. A minimum of two compressive strength tests shall be performed for each source of controlled low strength material.

3.14 CAPILLARY WATER BARRIER CONSTRUCTION

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade, one lift, and shall be compacted with a hand-operated plate-type vibratory compactor until no additional elevation changes occur in the surface of the material. The capillary water barrier shall be inspected and approved by the Contracting Officer prior to the placement of the vapor barrier or slab-on-grade.

3.15 VAPOR BARRIER CONSTRUCTION

Where indicated, a vapor barrier consisting of a 0.5 mm polyethylene sheet with a 100 mm sand cushion shall be placed directly under the building slab-on-grade and on top of the capillary water barrier. Adjacent edges of the polyethylene sheet shall be lapped by a minimum of 100 mm and sealed with pressure sensitive tape. All utility risers and other penetrations shall be completely wrapped and sealed with the polyethylene sheet and taped. The polyethylene sheet shall be inspected and approved by the

Contracting Officer prior to the placement of the sand cushion. The sand cushion layer shall be kept in a smooth and dry condition during reinforcement steel placement and shall be inspected prior to slab-on-grade placement. The sand cushion layer shall be protected during concrete placement.

3.16 GRADING

Areas within 1.5 m 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

Topsoil shall be imported from sources outside of Government controlled land. Areas to be topsoiled shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 50 mm 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 1.46 kN/m to 2.34 kN/m 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.

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SECTION 02222

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

PART 1 GENERAL

1.1 SCOPE OF WORK

This section specifies all earthwork for underground utilities systems under open areas, buildings, and pavement sections.

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 CONCRETE INSTITUTE

ACI 229R	(1994) Controlled Low Strength Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 136	(1993) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock
ASTM D 2487	(1992;R 1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System
ASTM D 3740	(1992) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 5255	(1992)Certification of Personnel Engaged in the Testing of Soil and Rock

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

EM 1110-2-1906	Laboratory Soils Testing
EM 1110-2-1907	Soils Sampling
EM 385-1-1	Safety and Health Requirements Manual
CESPK PAM 415-1-2	Construction Control Manual

1.3 DEFINITIONS

1.3.1 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D 1557 Procedure C.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-09 Reports

Field Density Tests; FIO. Testing of Backfill Materials; FIO.

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

Materials classified in ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, CL and combinations of these such as SP-SM are satisfactory for use on this project. Materials shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 50 mm. The portion passing the No. 40 standard sieve shall have a liquid limit of no greater than 35 when tested in accordance with ASTM D 4318.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as CH, MH, Pt, OH, and OL are unsatisfactory. Man-made fills and backfills of otherwise satisfactory materials from previous construction are unsatisfactory until compacted to the densities specified herein. Any materials that will not readily compact to the densities specified herein are unstable and unsatisfactory.

2.1.2.1 Unstable Materials

Materials that cannot be properly compacted or will not support

construction equipment or conduits and their appurtenances due to excessive moisture are unstable. Unstable material may be encountered at this site during utility excavation. Unstable conditions in excavations shall be mitigated as specified herein after. No additional compensation shall be forthcoming for the extra construction effort, time loss, or any other costs of remediation for unstable conditions.

2.1.3 Unyielding Material

Unyielding material shall consist of cemented soils that cannot be excavated with backhoe sized excavation equipment. Cemented soils may be encountered during excavation. No additional compensation shall be forthcoming for the extra construction effort and expense required for the excavation and replacement of cemented soils.

2.1.4 Foundations

The Contractor is notified that remnants of existing subgrade footings may exist at these sites and no additional compensation shall be forthcoming for any additional effort required for the removal and disposal of these.

2.1.5 Initial Backfill Material

Initial backfill material shall consist of the material specified by the conduit or coating manufacturer for the particular trench configuration and loading condition. Where conflicts in specifications exist, the more conservative (as determined by the Contracting Officer) material or alternative shall be utilized. In the absence of a conduit or coating manufacturer's specifications, initial backfill shall consist of select granular material, controlled low strength material or sand. Select granular material shall be used for bridging and general bedding and initial backfill. Controlled low strength material shall be used for bridging and bedding and initial backfill under heavily loaded areas and buildings. Sand shall be used as bedding and initial backfill for conduits that are coated for corrosion protection.

2.1.5.1 Select Granular Material

Select granular material shall consist of sands, gravels, crushed gravel, or crushed stone composed of hard, tough and durable particles. Select granular material shall be graded in accordance with the ASTM C 33 gradation for size 67 concrete coarse aggregate.

2.1.5.2 Controlled Low Strength Material

Controlled low strength material (CLSM) shall meet the requirements specified in ACI 229R and shall consist of a lean concrete slurry of type II portland cement blended with size 7 concrete coarse rounded aggregate conforming to the requirements specified in ASTM C 33. Controlled low strength material shall have a 28-day compressive strength of between 345 and 690 kPa when tested in accordance with ASTM C 39.

2.1.5.3 Sand

Sand shall conform to ASTM C 33 requirements for concrete fine aggregate. Additionally, sand shall have an inplace water content of less than 7 percent as determined by ASTM D 2216.

2.1.6 Plastic Marking Tape

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 152 mm (6 inches) wide with minimum thickness of 0.102 mm (0.004 inch). Tape shall have a minimum strength of 12.1 MPa (1750 psi) lengthwise and 10.3 MPa (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 1 meter 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

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. 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 600 mm. Excavated material not required or not satisfactory for backfill shall be removed from the site and shall be disposed of by the Contractor off of Government-controlled land prior to the completion of construction. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. No additional compensation shall be forthcoming for the excavation and replacement of materials from unauthorized overexcavation or for the remediation of unstable conditions, or materials rendered unsatisfactory by Contractor managed operations. No additional compensation shall be forthcoming for material excavation and replacement due to the Contractor's failure to protect, drain, or dewater the project site.

3.1.1 Trench Excavation

The trench shall be excavated as recommended by the manufacturer of the conduit 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 1.5 meters 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 1.5 meters 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. Trenches shall be be excavated to the width specified by the conduit manufacturer for the particular depth and loading condition. In the absence of manufacturer specifications the trench shall be excavated to provide a clearance of 75 to 150 mm between the trench wall and the inplace conduit. 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 of each section of the conduit. Excavation shall be of sufficient depth to provide clearance between the trench and conduit bottoms for bedding material.

3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed to the depth required to provide sufficient clearance for the conduit bedding.

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 or bridged with select granular material or controlled low strength material as directed.

3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures 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. 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.

3.1.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections. The Contractor shall vertically and horizontally locate all underground utilities in the vicinity of the operation and shall repair any broken or damaged utilities or pavements at no cost to the Government. The Contractor shall obtain all permits and clearances for the operation. All excavations shall be completely backfilled, compacted, and graded upon completion of testing.

3.1.1.6 Stockpiles

Stockpiles of satisfactory, unsatisfactory, and waste materials 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 and initial backfill material as required. Backfill shall be placed in layers not exceeding 150 mm loose thickness for compaction by hand operated machine compactors, and 200 mmloose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to densities specified herein after.

3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 0.6 meters above the top of pipe prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test and thrust blocks shall be allowed to cure for 48 hours prior to testing. Backfilling shall not be completed until all specified tests are performed and passed.

3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with 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 or bridged with select granular material or controlled low strength material as directed.

3.2.1.3 Bedding and Initial Backfill

Bedding shall consist of initial backfill material placed to the thickness shown. Care shall be taken to ensure thorough compaction of the bedding under the haunches of the pipe. 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. Initial backfill shall be placed in 6 inch loose lifts, each lift compacted with an approved hand-operated vibratory plate-type compactor until no additional surface elevation changes occur.

3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, shall be filled with satisfactory material. Placed conduits shall be protected from crushing by construction vehicles during subsequent construction operations. The Contractor shall repair damaged lines at no

additional cost to the Government. Backfill material shall be placed and compacted as follows:

a. Under Buildings: Backfill shall be placed and compacted to a minimum of 95 percent of the maximum laboratory dry density, full depth. Water flooding or jetting methods of compaction will not be permitted.

b. Under Areas to be Paved: Backfill shall be deposited and compacted to 93 percent of the maximum laboratory dry density. Compaction by water flooding or jetting will not be permitted.

c. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited and compacted to 90 percent of the maximum laboratory dry density. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

3.2.2 Backfill for Appurtenances

Appurtenant structures shall be backfilled with satisfactory material. After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 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 450 mm of cover in rock excavation and not less than 600 mm of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02685 GAS DISTRIBUTION SYSTEM.

3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 600 mm from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.3.3 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 600 mm 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 450 mm 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. Testing shall be performed by an approved commercial testing laboratory subject to approval and meeting the requirements specified in ASTM D 3740. Testing personnel shall meet the requirements outlined in ASTM D 5255. Information shall be submitted on a "Density Test Log" which shall include but not be limited to the following: test date, test number, feature of work, station/location, offset, elevation, inplace dry unit weight, moisture content, percent compaction, pass or fail, test method, and soil classification.

3.4.1 In-Place Densities

Field in-place density shall be determined in accordance with ASTM D 1556.

3.4.2 Moisture-Density Relationships

Moisture-density relationships shall be determined by the test method outlined in ASTM D 1557, Procedure C.

3.4.3 Gradation, Atterberg Limits, and Classification

Gradation testing aggregates shall be performed by the test method outlined in ASTM C 136. Gradation testing for soil materials shall be performed in accordance with ASTM D 422. Atterberg limits shall be determined by ASTM D 4318. Classification shall be determined by the test method outlined in ASTM D 2487.

3.4.4 Miscellaneous Testing

Wear tests for select granular material and controlled low-strength material aggregate shall be performed in accordance with ASTM C 131. Aggregates shall have a loss of no greater than 40 percent when tested with 500 revolutions. A minimum of two compressive strength tests shall be in accordance with ASTM C 39 for each source of controlled low strength material. Sieve size analysis for capillary water barrier material, sand, and controlled low-strength material aggregate shall be performed in accordance with ASTM C 136.

3.4.5 Testing Schedule

The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

(a) Field Density and Moisture Content: For utility trenches, perform one test for each lift or each increment or fraction of 60 meters. For isolated utility appurtenances, one random test during backfilling operations at each location.

(b) Moisture-Density Relationship with Gradation, Atterberg Limits, and Classification: From a bulk sample; one set of tests for every 5 field density tests (with not less than 1 test for each type of material) for the first 25 field density tests. Thereafter, one additional test for each change in material.

(c) Miscellaneous Granular Materials: For select granular material and controlled low-strength material aggregate; perform a minimum of two random

sieve size analyses and two wear tests for each material source. Perform a minimum of two sieve size analyses and two water content tests for inplace sand, if used for bedding and initial backfill. A minimum of two compressive strength tests shall be performed for each source of controlled low strength material.

3.5 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to 0.6 meters above the top of the pipe, 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 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.

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SECTION 02230

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SECTION 02230

CLEARING AND GRUBBING

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 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 down timber, snags, brush, and rubbish occurring in the areas to be cleared.

1.1.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm in diameter, and matted roots from the designated grubbing areas.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Materials Other Than Salable Timber; FIO.

Written permission to dispose of such products on private property shall be filed with the Contracting Officer.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CLEARING

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 40 mm 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 40 mm in diameter shall be painted with an approved tree-wound paint. 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.

3.2 GRUBBING

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 455 mm 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.

3.3 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 DISPOSAL OF MATERIALS

3.4.1 Materials Other Than Salable Timber

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.

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SECTION 02241

AGGREGATE BASE COURSE

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 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 127	(1988) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1988) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1992) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-1bf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 3740	(1992) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5255	(1992)Certification of Personnel Engaged in the Testing of Soil and Rock
ASTM E 11	(1987) Wire-Cloth Sieves for Testing Purposes

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EM 1110-2-1906	Laboratory Soils Testing
EM 1110-2-1907	Soils Sampling
EM 385-1-1	Safety and Health Requirements Manual
CESPK PAM 415-1-2	Construction Control Manual

1.2 DEFINITIONS

1.2.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 Procedure C abbreviated hereinafter as percent laboratory maximum dry density.

1.3 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Plant, Equipment, Machines, and Tools; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

SD-09 Reports

Sampling and Testing; FIO. Field Density; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

SD-18 Records

Waybills and Delivery Tickets; FIO. Coarse Aggregate; FIO.

Copies of waybills and delivery tickets during the progress of the work.

Certified waybills and delivery tickets for all materials actually used. A notification stating which type of coarse aggregate is to be used.

1.5 WAYBILLS AND DELIVERY TICKETS

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction.

1.6 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 2 degrees C. Base shall not be constructed on subgrades or subbases that are frozen or contain frost. If the temperature falls below 2 degrees C, completed areas shall be protected against any detrimental effects of freezing.

1.7 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.7.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

1.7.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 9072 kg, with a minimum weight of 5.4 kg/mm width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.7.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be loaded to weigh a minimum of 13,600 kg and have four or more tires. Tires shall be inflated to a minimum pressure of 1034 kPa. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

1.7.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.7.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.7.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.7.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 meter (12 foot) straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.8 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

1.9 SAMPLING AND TESTING

1.9.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory subject to approval and meeting the requirements of ASTM D 3740. Testing personnel shall meet the requirements outlined in ASTM D 5255. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed as specified herein after to insure that materials and compaction meet specified requirements. Field test information shall be submitted on a "Density Test Log" which shall include but not be limited to the following: test date, test number, feature of work, station/location, offset, elevation, inplace dry unit weight, moisture content, percent compaction, pass or fail, test method, and gradation.

1.9.2 Test Results

Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of tests. Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the

Contracting Officer.

1.9.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75.

1.9.4 Field Density with Moisture Content

Field in-place density and moisture content shall be determined in accordance with ASTM D 1556. Perform two tests per each increment or fraction of 500 square meters placed during each 8 hour shift.

1.9.5 Gradation with Atterberg Limits

Before starting work, at least one sample of material shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. Atterberg limits shall be determined by the test method outlined in ASTM D 4318. After the initial test, perform two sets of tests, on compacted material, for every 5 field density tests.

1.9.6 Moisture-Density Relationship

Moisture-density relationships from bulk samples shall be established with the test method outlined in ASTM D 1557, Procedure C. Perform one test for every 5 field density tests (with not less than 1 test for each type of material).

1.9.7 Wear Tests

Wear tests shall be performed on bulk samples in accordance with ASTM C 131. One test shall be run for every five field density tests (with not less than 1 test for each type of material).

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Aggregates

Aggregates shall consist of crushed stone, crushed gravel, angular sand, or other approved material. Aggregates shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a 4.75 mm sieve shall be known as coarse aggregate and that passing the 4.75 mm sieve shall be known as binder material.

2.1.1.1 Coarse Aggregate

Only one type of coarse aggregate shall be used on the project. Coarse aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the

maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone retained on each sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

2.1.2 Binder Material

Binder material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.3 Gradation

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a 25 mm maximum size and shall be continuously graded within the following limits:

Sieve Designation	Percent by Weight Passing Square-mesh Sieve (a)(b)(c)
25 mm	100
19 mm	87-100
4.75 mm	30-65
600 um	5-35
75 um	0-12

(a) Similar to Class 2 Aggregate Base, 19mm Maximum as specified in Section 26 of the State of California Department of Transportation *Standard Specifications*.

(b) Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested.

(c) The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravities are used.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

The subgrade surface on which the base course is to be placed shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as

necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Aggregates shall be obtained from off-site sources.

3.3 PREPARATION OF UNDERLYING COURSE

3.3.1 General Requirements

Before constructing aggregate base course, the subgrade shall be cleaned of foreign substances. The subgrade surface shall meet the specified compaction and surface tolerances. Subgrade shall conform to Section 02210 GRADING. Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface from requirements specified shall be corrected. The finished subgrade shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the base course is placed.

3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed area shall conform to the lines, grades, cross section, and dimensions indicated.

3.4 INSTALLATION

3.4.1 Mixing and Placing

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to ensure a satisfactory base course.

3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 300 mm width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

3.4.3 Compaction

Each layer of aggregate base course [including shoulders] shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least 98 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be

compacted with mechanical tampers, and shall be shaped and finished by hand methods.

3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be as indicated. No layer shall be in excess of 150 mm nor less than 75 mm in compacted thickness.

3.4.5 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

3.4.5.1 Smoothness

Surface of each layer shall show no deviations in excess of 9.5 mm (3/8 inch) when tested with the 3.66 meter (12-foot) straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

3.4.5.2 Thickness Control

Compacted thickness of the base course shall be within 12.7 mm (1/2 inch) of the thickness indicated. Where the measured thickness is more than 12.7 mm (1/2 inch) deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 12.7 mm (1/2 inch) thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6.4 mm (1/4 inch) of the thickness indicated.

3.5 FIELD QUALITY CONTROL

3.5.1 Field Density With Moisture Content

Perform two field density tests with moisture contents for each increment or fraction of 500 square meters placed during each 8 hour shift.

3.5.2 Gradation With Atterberg Limits

Before starting work, at least one sample of material shall be tested for gradation and Atterberg limit compliance. After the initial test, perform two sets of tests, on compacted material, for every 5 field density tests.

3.5.3 Moisture-Density Relationship

Perform one moisture-density relationship test for every 5 field density tests (with not less than 1 test for each type of material).

3.5.4 Wear Tests

One wear test shall be run for every five field density tests (with not less than 1 test for each type of material).

3.5.5 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 3.66 meter (12-foot) straightedge. Measurements shall also be taken perpendicular to the road centerline at 15 meter intervals.

3.5.6 Thickness

Thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 100 square meters of base course. Measurements shall be made by taking differential elevations at preselected locations between the subgrade and the top of the completed base course. Locations and subgrade elevations shall be delivered to the Contracting Officer prior to base course placement. Locations and top of base course elevations shall be delivered to the Contracting Officer within 24 hours of base course completion.

3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of as directed.

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SECTION 02285

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SECTION 02285

SOIL TREATMENT FOR SUBTERRANEAN TERMITE CONTROL

PART 1 GENERAL

1.1 REFERENCES (Not Applicable)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Qualifications; FIO.

Qualifications of the pesticide applicator.

SD-06 Instructions

Pesticides; FIO.

Manufacturer's label and Material Safety Data Sheet (MSDS) for pesticides proposed for use.

SD-14 Samples
Pesticides; FIO.

Samples of the pesticides used in this work, upon request.

1.3 QUALIFICATIONS OF PESTICIDE APPLICATORS

The pesticide applicator's principal business shall be pest control and the pesticide applicator shall be State certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control, and certified in the State.

1.4 DELIVERY, STORAGE, AND HANDLING

Pesticides shall be delivered to the project site in sealed and labeled containers in good condition as supplied by the manufacturer or formulator. Pesticides shall be stored, handled, and used in accordance with manufacturer's labels. Labels shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended.

1.5 SAFETY REQUIREMENTS

The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Water for formulating shall only come from sites designated by the Contracting Officer, and filling hose shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Pesticides and related materials shall be kept under

lock and key when unattended. Proper protective clothing and equipment shall be worn and used during all phases of termiticide application.

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 building. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contractor shall:

a. Re-treat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;

b. Repair damage caused by termite infestation; and

c. Reinspect the building approximately 180 days after the retreatment.

PART 2 PRODUCTS

2.1 MATERIALS

Termiticides shall be currently registered by the EPA.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

At the time of application, the soil moisture content shall be sufficiently low to allow uniform distribution of the treatment solution throughout the soil. Applications shall not be made during or immediately following heavy rains or when conditions may cause runoff and create an environmental hazard.

3.2 APPLICATION

3.2.1 Treatment of New Structures

The Contractor shall establish complete and unbroken vertical and/or horizontal (as necessary) soil poison barriers between the soil and all portions of the intended structure which may allow termite access to the polyethylene sheet of the vapor barrier or to wood and wood related products. Application shall not be made to areas intended for use as a plenum air space. Surface treatments shall not be made for areas to serve as crawl spaces. Termiticide shall be applied as a coarse spray and provide uniform distribution unto the soil surface. Treatment shall be applied prior to placement of a vapor barrier or waterproof membrane and at least 12 hours prior to concrete placement. Where treated soil or fill material is not to be covered with a vapor barrier or waterproof membrane, adequate precautions shall be taken to prevent its disturbance. Soil or fill material disturbed after treatment shall be re-treated as specified above before placement of slabs or other covering structures. Treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures shall be coordinated with final grading and planting operations so as to avoid disturbance of the treated barriers. Manufacturer's warnings and precautions shall be observed in the handling

and use of such materials. Care shall be taken to prevent these chemicals from entering water supply systems, potable water supplies, or aquifers; and that they do not endanger plants or animals. The Contracting Officer shall be notified at least 48 hours prior to beginning of treatment and formulating, mixing, and application shall be performed in the presence of the Contracting Officer's representative.

3.2.2 Rates and Methods of Application

Rates and methods of application shall be in accordance with the manufacturer's instructions on the pesticide label. Maximum application or dosage rates shall be used. If the pesticide contains less than the amount of active ingredient specified on the label, work shall be repeated with pesticides conforming to this specification.

3.3 DISPOSAL

The Contractor shall dispose of residual pesticides and containers off Government property in accordance with label instructions and EPA criteria.

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</END>

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SECTION 02511

CONCRETE SIDEWALKS, CURBS AND GUTTERS

PART 1 GENERAL

1.1 REFERENCES

The following referenced documents, standard practices and test methods represent the standard and care expected in the execution of Contractor quality control and quality assurance. The publications listed below form a part of this specification, but include only some of the most important or frequently used test methods. All cross referenced methods and standards also form a part of this specification to the extent needed to accomplish quality control and quality assurance. Standards and publications are often referred to in the text by their basic designation. If there is a conflict in test methods, the Government will determine which test or method governs.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 224	(1968; Rev. 1974) Protective Coatings for Portland Cement Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 171	(1992) Sheet Materials for Curing Concrete
ASTM C 309	(1993) Liquid Membrane-Forming Compounds for Curing Concrete
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 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467	(Rev C) Cloth, Burlap, Jute (or Kenaf)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-09 Reports

Field Quality Control; FIO

Copies of all test reports within 24 hours of completion of the test.

SD-18 Records

Concrete; FIO

Copies of certified delivery tickets for all concrete used in the construction.

1.3 WEATHER LIMITATIONS

1.3.1 Placing During Cold Weather

Concrete placement shall be discontinued when the air temperature reaches 5 degrees C and is falling. Placement may begin when the air temperature reaches 2 degrees C and is rising. 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 2 degrees C, placement shall be approved in writing. Approval shall 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 shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. 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 10 degrees C 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 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 35 degrees C.

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 c-urb 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 one pass.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 03300 CONCRETE FOR BUILDING CONSTRUCTION except as otherwise specified. Concrete shall have a minimum compressive strength of 21 MPa at 28 days. Maximum size of aggregate shall be 25 mm.

2.1.1 Air Content

Mixtures may have air content by volume of concrete of 3 to 5 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 75 millimeters plus or minus 25 millimeters where determined in accordance with ASTM C 143.

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 FS CCC-C-467.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.4 JOINT FILLER STRIPS

2.3 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 9.5 mm (3/8 inch) thick, unless otherwise indicated.

2.4.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.4.2 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 3 m 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 38 mm (1-1/2 inch) benders, for the full height of the curb, cleated together.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted to a minimum of 95 percent of the laboratory maximum density to a depth of 15 cm or the full depth of fill, whichever depth is greater.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 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 so as to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be carefully set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of three stakes per form placed at intervals not to exceed 1.2 meters. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to insure 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

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 3 mm in any 3 m long section. After forms

are set, grade and alignment shall be checked with a 3 m straightedge. Forms shall have a transverse slope as indicated 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 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer of such thickness that when consolidated and finished the sidewalks will 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 wood float, bull float, or darby, edged and broom finished.

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 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.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 3 mm. 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 7.9 mm (5/16 inch) from the testing edge of a 3.05 m (10-foot) straightedge. Permissible deficiency in section thickness will be up to 6.4 mm (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.

3.4.2 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 13 mm. 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.

3.4.3 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 6.4 mm (1/4 inch) from the testing edge of a 3.05 m (10-foot) straightedge. Permissible deficiency in section thickness will be up to 6.4 mm (1/4 inch).

3.5 SIDEWALK JOINTS

Sidewalk 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 1.5 m on centers, whichever is less, in no case shall the ratio of length to width exceed 1.25 to 1. The contraction joints and the expansion joints will be constructed as shown on the drawings. 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 3 mm (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 9.5 mm (3/8 inch) joint filler strips. Joint filler shall be placed with top edge 6 mm 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 3 mm, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer.

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 1.5 m nor greater than 4.5 m in length. Contraction joints shall be constructed by means of 3 mm 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 9.5 mm (3/8 inch) in width shall be provided at intervals not exceeding 15 meters. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated.

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 two or more layers of burlap. Mats shall overlap each other at least 150 mm. 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 300 mm when a continuous sheet is not used. The curing medium shall not be less than 450 mm 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. The compound must be shaded from the sun for 3 days. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters per liter (200 square feet per gallon) for both coats.

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 shall be applied to the exposed-to-view concrete surfaces in accordance with AASHTO M 224

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. The protective coating shall be applied in accordance to the manufacturer's recommendation. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.8 FIELD QUALITY CONTROL

The Contractor shall perform the inspection and tests in accordance to the Construction Control Manual. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports, and any additional tests to insure that the requirements of these specifications are met.

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 6 mm the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 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.

3.10 REMOVAL AND REPLACEMENT OF DEFECTIVE CONCRETE

Defective or damaged concrete shall be removed and replaced as specified herein, and a method of curing shall be employed as directed. All removed concrete shall be replaced with concrete of the thickness and quality required by these specifications. In no case shall the removal and replacement of concrete result in a slab less than the full sidewalk or curb and gutter width or a joint less than 1.5 m from a regularly scheduled transverse joint. The defective concrete shall be removed carefully so that the adjacent section is not damaged. When a portion of the unfractured slab is replaced, a full depth saw cut shall be made transversely across the slab in the required location, and the concrete shall be removed to provide a vertical face in the remaining portion of the slab. Prior to placement of the fresh concrete, the face of the slab shall be cleaned of debris and loose concrete. Transverse joints of the replaced slab or portion thereof shall be constructed as indicated. The joints shall be sealed as specified. Removal and replacement of defective or damaged concrete shall be accomplished by the Contractor at no additional cost to the Government.

3.11 CONSTRUCTION QUALITY CONTROL

Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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SECTION 02512

STAMPED COLORED CONCRETE

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 224	(1968; Rev. 1974) Protective Coatings for Portland Cement Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1985) Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
ASTM A 615	(1987) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616	(1987) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617	(1987) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 31	(1990) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1990) Concrete
ASTM C 33-86	Concrete Aggregates
ASTM C 143	(1990) Slump of Portland Cement Concrete
ASTM C 150-86	(1989) Portland Concrete Cement
ASTM C 171	(1969; R 1986) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 173	(1978) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(1989a) Air Content of Freshly Mixed concrete by the Pressure Method
ASTM C 260	(1986) Air-in-training Add Mixtures for

	Concrete
ASTM C 309	(1989) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 493	(1986) Standard Specification Chemical Add Mixtures for Concrete
ASTM C 979-82	(1986) Pigments for Integrally Colored Concrete
ASTM D 1751	(1983) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1850	(1974; R 1979) Concrete Joint Sealer, Cold-Application Type

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467	(Rev. C) Cloth, Burlap, Jute (or Kenaf)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL DESCRIPTIONS:

SD-01 Test Reports; FIO.

Copies of all test reports for tests specified in paragraphs "CONCRETE" and "FIELD QUALITY CONTROL" shall be submitted within 24 hours of the completion of the test.

SD-02 Records; FIO.

Copies of certified delivery tickets for all color compounds and concrete used in the construction shall be submitted.

SD-03 Test Plots; FIO.

Contractor shall provide test plots for all stamped colored concrete styles (minimum of 900mmlong)for color and finish approval and quality control.

1.3 WEATHER LIMITATIONS

1.3.1 Placing During Cold Weather

Concrete placement shall be discontinued when the air temperature reaches 4 degrees C and is falling. Placement may begin when the air temperature

reaches 1.6 degrees C and is rising. 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 1.6 degrees C, placement shall be approved in writing. Approval shall 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 shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 29.4 degrees C. 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 1.6 degreess C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.3.1 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 29.4 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 35 degrees C.

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. 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 Straightedge

The Contractor shall furnish and maintain at the jobsite, in good condition one 3000mm straightedge for testing the concrete surface. The straightedge shall be made available for Government use. The straightedge shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, reinforced to insure rigidity and accuracy. Straightedge shall have handles to facilitate movement on the concrete surface.

PART 2 PRODUCTS

2.1 CONCRETE

2.1 Stamped Color Concrete

Concrete shall conform to the applicable requirements of Section: 03300 CONCRETE FOR BUILDING CONSTRUCTION except as otherwise specified. Stamped colored concrete shall have a color hardener and releasing agent color as specified herein. *Finishes shall be one of two (2) imprinted textures as noted on the drawings. Patterns shall be as follows: Flag Stone, ["Westwood Brown"], 200mm Hex Tile ["Desert Sand"]. Bomanite Company or approved equal.* Text

2.1.1 Compression Strength

Concrete shall have a minimum compressive strength of 20684.28 kPa at 28 days. The maximum size of aggregate shall be as per integral color manufacturer specifications.Text

2.1.1.1 Air Content

Mixtures may have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.1.2 Slump

The concrete slump shall be 50mm plus or minus 10 percent where determined in accordance with ASTM C 143.

2.1.1.3 Compression Strength

Concrete shall have a minimum compressive strength of

2.1.2 Pedestrian Traffic Concrete

2.1.2.1 Compression Strength

Pedestrian traffic concrete shall have a minimum compressive strength of 20684.28 kPa at 28 days. The maximum size of aggregate shall be 25mmminus. Vehicular traffic concrete bands shall have a compression strength of 227579 kPa at 28 days. The maximum size of aggregate shall be 25mm minus.

2.1.2.2 Air Content

Mixtures may have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2.3 Slump

The concrete slump shall be 50mm plus or minus 1 percent where determined in accordance with ASTM C 143.

2.2 COLOR AGENTS

2.2.1 Color Hardener

A colored, ready-to-use, dry shake hardener for coloring, hardening and finishing new concrete. It shall be a streak-free intergration of pigments, surface conditioning an dispersing agents, and portland cement combined with hard, graded aggregate. *Color shall be "Desert Sand" and "Westwood Brown", L.M. Scofield Company or approved equal.* Mix and formulation shall be as per manufacturer specifications.

2.3 CONCRETE CURING

2.3.1 Burlap

Burlap shall conform to FS CCC-C-467.

2.3.2 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.Text

2.4 JOINT FILLER STRIPS

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.1 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 9mm thick, unless otherwise indicated.

2.5 FORM WORK

Form work shall be designed and constructed to insure 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, 50mm nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3000mm. Radius bends may be formed with 19mm 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 3000mm with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.5 Flatwork Forms

Flatwork forms shall be of a height equal to the full depth of the finished pavement.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement.

3.1.1 Concrete Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the pavement and supported between side forms.

3.1.2 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 so as to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be carefully set to the indicated alignment, grade and dimensions. Flatwork forms shall be held rigidly in place by a minimum of

three stakes per form placed at intervals not to exceed 1200mm. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to insure 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.

3.3 CONCRETE PLACEMENT AND FINISHING

3.3.1 Placement

After installation of steel reinforcing where specified, concrete shall be placed in the forms in one layer of such thickness that when consolidated and finished the bands, planters, and fountain footing will 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 exposed surface shall be finished to grade with a wood float, bull float, or darby, edged and finished as specified.

3.3.2 Stamped Colored Concrete Finishing

Exposed surfaces shall be screeded and floated with a smooth wood float until true to grade and section and is uniform in texture and free from irregularities. Colored hardener shall be applied evenly to the plastic surface by the dry-shake method using a minimum of 8kg/m2. it shall be applied in two shakes, wood floated after eah, and troweled only after set, the final floating. While concrete is still in the plastic stage of set, apply a portland concrete approved releasing agent imprinted and textured surface. the colored curing and finishing compound used shall be thinned and applied in acordane with manufacturer's speifications. The coverage shall be approximately 56-60m2 per 3.78 liters of unthinnned color wax.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 3mm. 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 7.5mm from the testing edge of a 3000mm straightedge. Permissible deficiency in section thickness will be up to 6.3mm

3.4 FLATWORK JOINTS

Flatwork 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 up to a maximum of 4.5M on centers, and in no case shall the ratio of length to width exceed 1.25 to 1. The contraction joints

and the expansion joints will be constructed as shown on the drawings. Transverse expansion joints shall be installed at sidewalk returns. 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.

3.4.1 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 e approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 3mm blade to the depth indicated.

3.4.2 Expansion Joints

Transverse expansion joints shall be installed at sidewalk returns. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated or at intervals of not less than 9M or more than 15M.

Expansion joints shall be formed with 9mm joint filler strips. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3mm.

3.5 CURING AND PROTECTION

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. Curing methods can be the Mat Method (Burlap), Impervious Sheeting Method, and White pigmented Membrane Curing Compounds. Any method used shall be subject to approval of the Contracting Officer.

3.5.1 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.

3.5.2 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction

3.6 FIELD QUALITY CONTROL

The Contractor shall perform the inspection and tests in accordance to the Construction Control Manual. 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.

3.7 SURFACE DEFICIENCIES AND CORRECTIONS

3.7.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficiency in thickness by more than 6.3mm the deficient section will be removed, between regularly scheduled joints, and replaced.

3.7.2 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 and approved test plots shall be removed and replaced.

3.8 REMOVAL AND REPLACEMENT OF DEFECTIVE CONCRETE

Defective or damaged concrete shall be removed and replaced as specified herein, and a method of curing shall be employed as directed. All removed concrete shall be replaced with concrete of the thickness and quality required by these specifications. In no case shall the removal and replacement of concrete result in a slab less than the full sidewalk or curb and gutter width or a joint less than 1.5M from a regularly scheduled transverse joint. The defective concrete shall be removed carefully so that the adjacent section is not damaged. When a portion of the unfractured slab is replaced, a full depth saw cut shall be made transversely across the slab in the required location, and the concrete shall be removed to provide a vertical face in the remaining portion of the slab. Prior to placement of the fresh concrete, the face of the slab shall be cleaned of debris and loose concrete. Transverse joints of the replaced slab or portion thereof shall be constructed as indicated. The joints shall be sealed as specified. Removal and replacement of defective or damaged concrete shall be accomplished by the Contractor at no additional cost to the Government

3.9 CONSTRUCTION QUALITY CONTROL

Attention is directed to Section 01451 CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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SECTION 02513

BITUMINOUS COURSE
(CENTRAL-PLANT HOT MIX)

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988; R1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993)Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Sized Course Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1993) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 5	(1986) Penetration of Bituminous Materials
ASTM D 75	(1987; R1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1985; R 1990) Mineral Filler for Bituminous Paving Mixtures
ASTM D 1559	(1992) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(1991) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3666	(1993) Minimum Requirement for Agencies Testing and Inspecting Bituminous Paving Materials

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-09 Reports

Bituminous Pavement; FIO.

Copies of test results.

1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.4.1 Mixing Plants

Mixing plant shall be a weigh-batch, continuous-mix type or dryer drum type and operated so as to produce a mixture within the job-mix formula. The plant shall have a minimum capacity of 90 metric tons per hour.

1.4.2 Other Equipment

1.4.2.1 Spreaders

Bituminous-materials spreaders shall be self-propelled, capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The use of a spreader that leaves indentations or other objectionable irregularities in the freshly-laid mix is not permitted.

1.4.2.2 Blowers and Brooms

Blowers and brooms shall be of the power type suitable for cleaning the surface to be paved.

1.4.2.3 Saws

Saws shall be of the power type, capable of rapidly cutting pavement and trimming joints and edges of pavement.

1.4.2.4 Small Tools

Small tools available on the work shall consist of the following: rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heater for heating small tools, wood sandles and stilt sandals of standard type, and other small tools as may be required. A sufficient number shall be available at all times. The lutes shall be constructed of metal and shall consist of a plate or sheet 1 meter x 0.1 meter attached to a handle properly braced. Hand tampers shall weigh not less than 12 kg and have a tamping face not larger than 0.032 square meters.

1.4.2.5 Straightedge

The Contractor shall furnish and maintain at the site, in good condition,

one 3.65 meter (12-foot) straightedge for each bituminous paver. The straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

1.4.3 Rollers

The minimum number of rollers for each spreader shall be one 2-axle tandem roller and one pneumatic-tired roller, with separate operator for each roller.

1.4.3.1 Steel Wheeled Rollers

Steel-wheel rollers shall be a self-propelled 2-axle tandem roller weighing not less than 9 metric tons. The rollers shall have adjustable wheel scrapers, water tanks, and sprinkling apparatus to keep the wheels sufficiently wet to prevent the bituminous mixture from sticking to the wheels. The rollers shall be capable of reversing without backlash and shall be free from worn parts. The roller wheels shall not have flat or pitted areas or projections that will leave marks in the pavement.

1.4.3.2 Pneumatic-tired Rollers

Pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted multiple pneumatic-tired wheels in such manner that the rear group of wheels will not follow in the tracks of the forward group but spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth and capable of being inflated to at least 620 kPa. Construction of roller shall be such that each wheel can be loaded to a minimum of 2100 kg.

1.5 WEATHER LIMITATIONS

Bituminous course shall be constructed only when base course and existing pavement is dry. Unless otherwise directed, bituminous course shall not be constructed when temperature of the surface of existing pavement or base course is below 5 degrees C.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of crushed stone, crushed gravel, screenings, sand, and mineral filler. Aggregates shall have a satisfactory service record in bituminous pavement construction, and the source selected shall be approved by the Contracting Officer. The combined aggregates and mineral filler shall meet the requirements of subsequent paragraphs AGGREGATE GRADATION and COMPOSITION OF MIXTURE.

2.1.1 Coarse Aggregates

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements:

a. Loss not greater that 40 percent after 500 revolutions when tested in accordance with ASTM C 131.

b. Loss not greater than 12 percent after five cycles of testing in accordance with ASTM C 88, using sodium sulfate.

c. At least 50 percent by weight of the aggregates retained on the 4.74 mm sieve shall have at least two fractured faces.

2.1.2 Fine Aggregates

Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone or gravel that meet the requirements for wear and soundness specified for coarse aggregates. This requirement shall apply to material before blending with natural sand when blending is necessary.

2.1.3 Mineral Filler

Material passing the 75 um sieve shall be known as mineral filler, and shall conform to ASTM D 242.

2.1.4 Aggregate Gradation

The aggregate gradation as determined by ASTM C 136 shall fall within the limits of the following:

Sieve Designation	Percent by Weight Passing Square-mesh Sieve (a)
19 mm	100
12.5 mm	95-100
9.5 mm	80-95
4.75 mm	59-66
2.36 mm	43-49
600 um	22-27
75 um	3-8

(a) Similar to the California Gradation for 12.5 mm maximum, medium per Section 39 of the California Department of Transportation *Standard Specifications*.

2.2 BITUMINOUS MATERIAL

Bituminous material to be mixed with the mineral aggregates shall be paving asphalt conforming to ASTM D 3381, Viscosity-Graded Asphalt Cement for Use in Pavement Construction as listed in Table 3, Requirements for Asphalt Cement Viscosity-Graded at 60 degrees C. Paving asphalt viscosity grade shall be AR-4000. Certified results of tests conducted in accordance with ASTM D 5 shall be submitted in advance of any paving, showing the penetration at 25 degrees C for the AR grades of asphalt that will actually be used in the paving mix of this project. In addition, the penetration range at 25 degrees C shall be 25.

2.3 COMPOSITION OF MIXTURE

2.3.1 Job-Mix Formula

The job-mix formula shall be performed in accordance with ASTM D 1559 and shall be submitted by the Contractor a minimum of 30 days prior to the

commencement of paving operations. No bituminous mixture shall be manufactured until it has been approved by the Contracting Officer. Data shall be presented with respect to the asphalt cement content in tabulated form, as well as graphical form, and shall include curves for unit weight, percent voids of total mix, percent voids filled, stability, and the optimum asphalt content. Additionally, the formula shall indicate the percentage and specific gravity of each bin fraction of aggregate, percentage absorption and specific gravity of asphalt, temperature of the mixture as discharged from the mixer; and test results which show that the job mix formula will produce a bituminous mixture which meets all requirements of this specification. The Contractor may, at its option, use ASTM D 2041 to determine the theoretical specific gravity for the paving mixture. If ASTM D 2041 is used, the physical test properties of the paving mixture shall meet the requirements of TABLE 1, located herein after, regardless of whether the aggregates are absorptive or non-absorptive. Previously established test results will be acceptable provided that the tests were performed within the last six months. The asphalt in the job-mix formula shall be between 4.5% and 7.5% of the weight of the total mix. If requested by the Contracting Officer, samples of the aggregates and asphalt shall be submitted for approval of the job-mix formula.

2.3.2 Test Properties of Bituminous Mixtures

2.3.3 Nonabsorptive Aggregate

When the water absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined by ASTM C 127 and ASTM C 128, aggregate is designated as nonabsorptive. The test method outlined in ASTM D 2041 may be utilized for the determination of the theoretical maximum specific gravity and density of the paving mixture providing that the mixture meets the requirements of Table 1. The apparent specific gravity shall be used in computing the voids total mix and voids filled with bitumen. Stability and flow shall be determined in accordance with ASTM D 1559. The mixture shall meet the requirements of Table 1 herein.

TABLE 1. NONABSORPTIVE AGGREGATE MIXTURE

Test Property	50-Blow Compaction
Stability, minimum, Newtons	4450
Flow, 0.25 mm units	8 minimum, 20 maximum
Voids total mix, percent	3-5
Voids filled with bitumen, percent	75-85

2.3.4 Absorptive Aggregate

When the water absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The test method outlined in ASTM D 2041 may be utilized for the determination of the theoretical maximum specific gravity and density of the paving mixture providing that the mixture meets the requirements of Table 2. Bulk-impregnated specific gravity shall be used in computing the percentages of voids total mix and voids filled with bitumen. Stability and flow shall be determined in accordance with ASTM D 1559. The mixture shall meet the requirements in Table 2, herein.

TABLE 2. ABSORPTIVE AGGREGATE MIXTURE

Test Property	50-Blow Compaction
Stability, minimum, Newtons	4450
Flow, 0.25 mm units	8 minimum, 20 maximum
Voids total mix, percent	2-4
Voids filled with bitumen, percent	80-90

2.3.5 Stripping of Aggregates

After 24 hours immersion in water bath controlled at a temperature of 60 degrees C., the retained stability of job-mix formula test specimens shall be at least 75 percent of the stability of companion specimens prepared for the job-mix formula when tested in accordance with ASTM D 1559. If the retained stability is less than the required 75 percent, the aggregates shall be either rejected or treated by one of the following procedures until the retained stability reaches the required 75 percent: (1) Addition of heat-stable additives to bitumen; (2) addition of hydrated lime, or other cementitious material containing free lime, as a portion of the mineral filler.

PART 3 EXECUTION

3.1 SAMPLING AND TESTING

The testing laboratory and all field and laboratory testing personnel shall meet the requirements specified in ASTM D 3666. Aggregate sampling shall be performed in accordance with ASTM D 75. Bituminous materials shall be sampled in accordance with ASTM D 140. All 100 mm in diameter core samples shall be suitable to determine conformance with stability, density, thickness and other specified requirements. An approved core drill shall be used for cutting samples. The Contractor shall furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed, to the satisfaction of the Contracting Officer.

3.1.1 Testing Frequency

All sampling and control testing for construction of the pavement shall be performed by the Contractor in accordance with the requirements outlined in Chapter 4 of CESPK PAM 415-1-2 except that the metric versions of the referenced ASTM standards shall be used.

a. Asphalt: Collect a 1 liter sample of asphalt and the refinery certification. Resample anytime the bituminous material source changes.

b. Aggregate: Collect a minimum of two 23 kg samples of mix aggregate from the hot bins; one sample at the beginning of each 8-hour shift and the other at mid-shift. Each 23 kg sample shall be split in half. The two half-samples (from the beginning and mid-shift) shall be labeled and packed separately and submitted to the Contracting Officer within 24 hours of sampling. Retain two half-samples for QC testing.

c. Hot Mix: Collect a minimum of two 32 kg samples of hot mix from the belt or transport truck; one sample at the beginning of each 8-hour shift

and the other at mid-shift. Each 32 kg sample shall be split in half. The two half-samples (from the beginning and mid-shift) shall be labeled and packed separately and submitted to the Contracting Officer within 24 hours of sampling. Retain two half-samples for QC testing.

d. Core Specimens: Collect 1 set of 5 cores per each hot mix sample collected (if possible, 2 cores from the centerline of joints). Number cores and note the locations obtained on the as-built drawings. From each set, 2 cores shall be submitted to the Contracting Officer (preferably 1 core from a joint centerline). Retain remaining cores for QC testing. Testing shall be in accordance with the Marshall test procedures of ASTM D 1559 and shall meet or surpass the requirements specified herein before. No payment will be made for areas of pavement deficient in composition, density, or thickness until they are removed and replaced by the Contractor as directed by the Contracting Officer.

e. Smoothness Testing: Perform testing at 15 meter intervals along the section centerlines of the parking areas and access ways as specified in the paragraph SURFACE REQUIREMENTS. Perform two tests at each patched area; one each on each side of the traveled way centerline.

3.2 TREATMENT OF UNDERLYING SURFACE

Prior to laying a bituminous course, the underlying surface shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, and hand brooms, as directed. The surface to be paved shall receive a prime coat conforming to Section 02558 BITUMINOUS TACK AND PRIME COATS.

3.3 MIXING

Temperature of asphalt at time of mixing shall not exceed 163 degrees C when asphalt is added.

3.4 TRANSPORTATION OF BITUMINOUS MIXTURE

The bituminous mixture shall be transported from the mixing plant to the site in trucks having tight, clean, smooth bodies with a minimum coating of concentrated solution of hydrated lime and water to prevent adhesion of the mixture. Each load of mixture shall be covered with canvas or other suitable material to protect the mixture from the weather and to prevent loss of heat. Mixtures having temperatures greater than 163 degrees C, mixtures having temperatures less than 118 degrees C, or mixtures which foam or show indications of moisture will be rejected. Hauling over freshly laid material is not permitted.

3.5 PLACING

Contact surfaces of previously constructed pavement, curbs, manholes, or other structures shall be sprayed with a thin coat of bituminous tack coat in accordance with Section 02558 BITUMINOUS TACK AND PRIME COATS. The mechanical spreader shall be adjusted and its speed regulated so that the course being placed will be smooth and continuous without tears and pulling. The course will be of such depth that after compaction, the cross section, grade, and contour will be as shown on the drawings. In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Unless otherwise directed, placing shall begin on the high side of areas with a one-way slope or along the centerline of areas with a crowned section and shall be in the direction of the main traffic flow.

Placing of the mixture shall be as continuous as possible, and the speed of placing shall be adjusted to permit proper rolling.

3.6 COMPACTION OF ASPHALT MIXTURE

Compaction of asphalt mixture shall be accomplished by the steel wheel rollers and pneumatic-tired roller specified above.

3.6.1 Rolling

Rolling shall begin as soon after placing as the mixture will support the roller without undue displacement. Breakdown rolling shall consist of at least three coverages of a layer of asphalt mixture with a steel wheel roller, immediately followed by at least three coverages with a pneumatic-tired roller. A coverage is defined to be as many passes in either direction as may be necessary to cover the entire width of lane with overlap between passes. Each layer shall be additionally compacted by a final rolling of not less than one coverage with a 2-axle tandem roller. The speed of the rollers shall not exceed 3 miles per hour and rolling shall be performed in such a manner to avoid cracking, shoving, or displacement of the hot mixture.

3.6.1.1 Vibratory Steel Wheeled Rollers

Use of vibratory steel wheel roller for breakdown and finish rolling is subject to prior approval. Vibratory roller shall be operated with the vibratory units off for finish rolling. The maximum weight of the vibratory roller shall not exceed 45 kN.

3.6.1.2 Mixture Density

The bituminous mixture shall be compacted to at least 95 percent of the density of the laboratory specimen of the same mixture subjected to 50 blows of a standard Marshall hammer on each side of the specimen. In areas not accessible to the roller the mixture shall be compacted with hot hand tampers. The compacted surface shall be smooth and free from roller marks, ruts, humps, depressions, or irregularities.

3.6.1.3 Compacted Thickness

The mixture shall be placed in one lift and compacted to the thicknesses indicated within the tolerances specified herein. Patched areas shall match the thickness of the existing pavement adjacent to the patch.

3.7 JOINTS AND EDGES

Joints between old and new pavements or between successive day's work, or joints that have become cold because of delay, shall be made to insure continuous bond between old and new sections of course. All joints shall have the same texture, density, and smoothness as other sections of course. Contact surfaces of previously constructed pavements that have become coated with dust, sand or other objectionable material shall be cleaned by brushing or cut back with approved power saw, as directed. The surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous tack coat.

3.7.1 Transverse Joints

The roller shall pass over the unprotected end of freshly placed mixture

only when placing of course is discontinued or when delivery of mixture is interrupted to the extent that unrolled material may become cold. In all cases, edge of the previously placed course shall be sawn back to expose an even, vertical surface the full thickness of the course.

3.7.2 Longitudinal Joints

Edges of previously placed strip that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective, and unsatisfactory sections of the joint shall be sawn back to expose clean, sound surface for full thickness of the course as directed.

3.7.3 Pavement Edges

Edges of pavement adjacent to shoulders shall be trimmed neatly to line. An earth berm of selected material not less than 0.3 meters wide shall be placed against and to the full height of the pavement surface as soon as practicable after final rolling has been completed and pavement has sufficiently hardened.

3.8 PROTECTION OF PAVEMENT

No vehicular traffic shall be permitted on the pavement for at least 6 hours after final rolling.

3.9 SURFACE REQUIREMENTS

The finished surface shall not vary more than 6 mm (1/4-inch) from a3.66 meter straightedge. The straightedge shall be furnished by the Contractor. Defective areas and any other areas that impound surface water shall be corrected by and at the expense of the Contractor. Straightedge testing shall be performed as a Contractor Quality Control requirement to demonstrate compliance.

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-- End of Section Table of Contents --

SECTION 02558

BITUMINOUS TACK AND PRIME COATS

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 OF TESTING AND MATERIALS (ASTM)

ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 2397	(1994) Cationic Emulsified Asphalt
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
ASTM D 3666	(1993) Minimum Requirement for Agencies Testing and Inspecting Bituminous Paving Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-09 Reports

Tests; FIO.

Copies of all test results for bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

SD-18 Records

Waybills and Delivery Tickets; FIO.

Waybills and delivery tickets, during progress of the work.

1.3 PLANT, EQUIPMENT, MACHINES AND TOOLS

1.3.1 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.

1.3.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

1.3.3 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the bituminous coat is to be applied.

1.4 WEATHER LIMITATIONS

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C or above and when the temperature has not been below 2 degrees C for the 12 hours prior to application.

PART 2 PRODUCTS

2.1 TACK COAT

Emulsified asphalt shall conform to ASTM D 977 or ASTM D 2397, Grade SS-1 or CSS-1.

2.2 PRIME COAT

Emulsified asphalt shall conform to ASTM D 977 or ASTM D 2397, Grade SS-1 or CSS-1.

PART 3 EXECUTION

3.1 PREPARATION OF EMULSION

Bituminous materials for emulsions shall be diluted by adding equal volumes of bituminous material and compatible water. If the bituminous materail is to be diluted in the field, first test the mix by placing equal volumes of emulsion and water in a glass quart jar (do not use a metal container, as it could cause the mixture to "break") and mix for one minute. If the mixture "breaks", a different source of water or bituminous material is required.

3.2 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment.

3.3 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

3.3.1 Tack Coat

Bituminous material for the tack coat shall be applied in quantities of not less than 0.20 liter nor more than 0.70 liter per square meter of pavement surface.

3.3.2 Prime Coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.70 liter nor more than 1.80 liters per square meter of pavement surface.

3.4 APPLICATION TEMPERATURE

3.4.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 square mm/sec, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

3.4.2 Temperature Ranges

The viscosity requirements shall determine the application temperature to be used. The following is a normal range of application temperatures:

Emulsions	
SS-1	20-70 degrees C
CSS-1	20-70 degrees C

3.5 APPLICATION

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Until the succeeding layer of pavement is placed, the surface shall be maintained by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper.

3.6 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

3.7 FIELD QUALITY CONTROL

Field quality control shall be conducted by personnel meeting the requirements outlined in ASTM D 3666. Samples of the bituminous material may be tested for compliance with the applicable specified requirements. A sample shall be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample may be retained and tested by the Government at no cost to the Contractor.

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SECTION 02580

PAVEMENT MARKINGS

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; Rev 1986) Glass Beads Used in Traffic Paint
AASHTO M 248	(1991I) Ready-Mixed White and Yellow Traffic Paints

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 4280	(1995) Extended Life Type, Nonplowable, Prismatic, Raised, Retroreflective Pavement Markers
ASTM D 4505	(1992) Preformed Plastic Pavement Marking Tape for Extended Service Life
ASTM E 28	(1992) Softening Point by Ring-and-Ball Apparatus

FEDERAL SPECIFICATIONS (FS)

FS TT-B-1325	(Rev C) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Marking, Waterborne (Metric)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Lists; GA.

Lists of proposed equipment to be used in performance of construction work, including descriptive data, and notifications of proposed Contractor actions as specified in this section.

SD-06 Instructions

Mixing, Thinning and Application; FIO.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

SD-09 Reports

Material Tests; FIO.

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-13 Certificates

Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

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.

1.4.1 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 300 mm (12 inches). The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

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 70.8

liters per sec (150 cfm) of air at a pressure of not less than 620 kPa (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 17.9 MPa (2600 psi) at 60 degrees C (140 degrees F in order to adequately clean the surfaces to be marked.

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 shall 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.

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. Paint for roads, streets, and parking areas shall conform to [AASHTO M 248], 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 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

2.3 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

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, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

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 5 degrees C and less than 35 degrees C. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces 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 herein. The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 10 plus or minus 0.5 square meter per liter.

Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 10 plus or minus 0.5 square meter per liter.

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 Preformed Tape

The pavement surface temperature shall be a minimum of 15 degrees C and the ambient temperature shall be a minimum of 15 degrees C and rising. The preformed markings shall be placed in accordance with the manufacturer's written instructions.

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SECTION 02660

WATER DISTRIBUTION SYSTEM

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 RAILWAY ENGINEERING ASSOCIATION (AREA)

AREA MRE	(1994) Manual for Railway Engineering (Fixed Properties): Chapter 1, Roadway and Ballast

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM C 76	(1995) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM D 1599	(1988) Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1993) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1993) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1993) Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D 2657	(1990) Heat-Joining Polyolefin Pipe and Fittings
ASTM D 2774	(1972; R 1983) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1993) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3839	(1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM F 477	(1993) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B36.10M	(1985; R 1994) Welded and Seamless Wrought Steel Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1990) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
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	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1988) Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994) Ductile-Iron Compact Fittings, 3 In. Through 16 In., for Water and Other Liquids
AWWA C200	(1991) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C205	(1989) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
AWWA C208	(1983; C208a; R 1989) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C300	(1989) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C301	(1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C303	(1987; Errata Jan 1988) Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C500	(1993) Gate Valves for Water and Sewerage Systems
AWWA C502	(1985) Dry-Barrel Fire Hydrants
AWWA C503	(1988) Wet-Barrel Fire Hydrants
AWWA C504	(1994) Rubber-Seated Butterfly Valves
AWWA C509	(1994) Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances

AWWA C606	(1987) Grooved and Shouldered Joints
AWWA C651	(1992) Disinfecting Water Mains
AWWA C700	(1990; C700a) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C702	(1992) Cold-Water Meters - Compound Type
AWWA C703	(1986) Cold-Water Meters - Fire Service Type
AWWA C704	(1992) Cold-Water Meters - Propeller Type for Main Line Applications
AWWA C706	(1991; C706a) Direct-Reading Remote-Registration Systems for Cold-Water Meters
AWWA C707	(1982; R 1992) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(1989) Underground Service Line Valves and Fittings
AWWA C900	(1989; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA C901	(1988; Errata Apr 1988) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service
AWWA C905	(1988) Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.
AWWA C950	(1988) Fiberglass Pressure Pipe
AWWA M23	(1980) Manual: PVC Pipe - Design and Installation

ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA-01	(1988) Recommended Work Practices for A/C Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-01	(1992; Errata May 1993) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(1992) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 49	(1991) Hazardous Chemicals Data
NFPA 325M	(1991) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1990) Identification of the Fire Hazards of Materials
NFPA 1961	(1992) Fire Hose

NSF INTERNATIONAL (NSF)

NSF Std 14	(1965; Rev Nov 1990) Plastics Piping System Components and Related Materials

STEEL STRUCTURES PAINTING COUNCIL (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 1.5 m 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 for sizes 80 mm (3 inches) and larger shall be ductile iron, polyvinyl chloride (PVC) plastic through 300 mm (12 inch) nominal diameter, filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe or steel, unless otherwise shown or specified.

1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 80 mm (3 inches) or larger shall be ductile iron, polyvinyl chloride (PVC) plastic through 300 mm (12 inch) nominal diameter, filament-wound or centrifugally cast reinforced thermosetting resin, or reinforced plastic mortar pressure pipe, unless otherwise shown or specified.

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 1.5 m line.

1.2.4 Plastic Pipe

All plastic piping system components (PVC, thermosetting resin and reinforced plastic mortar pressure) intended for transportation of potable water shall comply with NSF Std 14 and shall 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 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

1.3 MANUFACTURER'S REPRESENTATIVE

The Contractor shall negotiate to have a manufacturer's field representative present at the jobsite during the installation and testing of RTRP, and/or RPMP pipe to provide technical assistance and to verify that the materials are being installed in accordance with the manufacturer's prescribed procedures. When the representative feels that the Contractor is installing and testing the RTRP, and/or RPMP pipe in a satisfactory manner, certification shall be written to note which individuals employed by the Contractor are capable of properly installing the pipe. The field representative shall advise the Contractor of unsatisfactory conditions immediately when they occur. Such conditions include improper diameter of pipe ends, damaged interior liner, poorly prepared joints, improper curing of joints, moving pipe before joints are cured, bending pipe to follow abrupt changes in trench contours, leaving pipe ends open in trench overnight, not properly drying joints after rain storms, exceeding effective adhesive life, sharp objects in trench bed, backfill that could damage pipe, improper procedure for concrete encasement of pipe, omission of thrust blocks at changes in direction or any other conditions which could have an adverse effect on the satisfactory completion and operation of the piping system.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Installation; FIO.

The manufacturer's recommendations for each material or procedure to be utilized.

SD-08 Statements

Waste Water Disposal Method; FIO.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation; FIO.

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

SD-09 Reports

Bacteriological Disinfection; FIO.

Test results from commercial laboratory verifying disinfection.

SD-13 Certificates

Manufacturer's Representative; FIO.

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

Installation; FIO.

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.

1.5 HANDLING

Pipe and accessories shall be handled so as to ensure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure 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 at his expense in a satisfactory manner. No other pipe or material of any kind 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.

1.5.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

1.5.2 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 325M.

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 Polyvinyl Chloride (PVC) Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

a. Pipe Less Than 100 mm (4 inch) Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa (150 psi) working pressure, 1.38 MPa (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 1.03 MPa (150 psi) working pressure, 1.38 MPa (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 MPa	Minimum Hydrostatic Pressure MPa
26	0.689	0.917
21	0.827	1.103
17	1.034	1.379
13.5	1.379	1.834

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa (150 psi) working pressure and 1.38 MPa (200 psi) hydrostatic test pressure.

b. Pipe 100 mm (4 inch) through 300 mm (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.

2.1.2 Reinforced Plastic Mortar Pressure (RPMP) Pipe

AWWA C950.

2.1.3 Reinforced Thermosetting Resin Pipe (RTRP)

Pipe shall have a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test shall conform to the requirements of ASTM D 1599.

2.1.3.1 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 1.03 MPa (150 psi) at 23 degrees C. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

2.1.3.2 RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

2.1.4 Ductile-Iron Pipe

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa (150 psi), unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. When installed underground, pipe shall be encased with [_____] mil thick polyethylene in accordance with AWWA C105. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

2.1.5 Steel Pipe

2.1.5.1 Pipe 80 mm (3 Inches) and Larger, Not Galvanized

Steel pipe, not galvanized, shall conform to AWWA C200 with dimensional requirements as given in ASME B36.10M for pipe 150 mm (6 inches) in diameter and larger, and ASTM A 53 for smaller sizes. Pipe shall be welded or seamless with plain or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Bell-and-spigot ends for sizes less than 150 mm (6 inches) diameter shall be as required by AWWA C200. The minimum wall thickness of the various sizes of pipe shall be as follows:

Pipe Sizes	Thickness
[_____]	[_____]

2.1.5.2 Protective Materials for Steel Pipe

Protective materials for steel pipe, except as otherwise specified, shall be mechanically applied in a factory or plant especially equipped for the purpose. The materials shall, unless otherwise indicated on the drawings, consist of one of the following for the indicated pipe material and size:

b. Pipe 80 mm (3 Inches) or Larger, Not Galvanized:

(1) Cement-mortar coating and lining shall conform to and shall be applied in conformity with AWWA C205. Cement-mortar coating and linings shall not be used for pipe less than 100 mm (4 inches) in diameter.

(2) Coal-tar enamel lining, coating and wrapping shall conform to AWWA C203 for materials, method of application, tests and handling. Non-asbestos material shall be used for the outerwrap.

(3) Cement-mortar lining, in lieu of coal-tar enamel lining, may be used with coal-tar enamel coating and wrapping. Cement-mortar lining shall conform to and shall be applied in conformity with AWWA C205.

2.2 FITTINGS AND SPECIALS

2.2.1 Polyvinyl Chloride (PVC) Pipe

a. For pipe less than 100 mm (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 100 mm (4 inch) diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 1.03 MPa (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 may be fittings and specials 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 RTRP and RPMP Pipe

Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm (6 inches) shall conform to AWWA C950. Iron fittings shall be cement-mortar lined in accordance with AWWA C104 and shall conform to AWWA C110 and AWWA C111. Fittings shall be suitable for working and testing pressures specified for the pipe.

2.2.3 Ductile-Iron Pipe

Fittings and special shall be suitable for 1.03 MPa (150 psi) pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153.

2.2.4 Steel Pipe

2.2.4.1 Steel Pipe Not Galvanized

Fittings and specials shall be made of the same material as the pipe.

Specials and fittings may be made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Dimensions of steel-pipe fittings shall be in accordance with AWWA C208. The thickness and pressure rating of pipe fittings and specials shall be not less than the thickness specified and the pressure rating calculated for the pipe with which they are used. Protective materials for fittings and specials shall be as specified for the pipe. Specials and fittings that cannot be mechanically lined, coated, and wrapped shall be lined, coated, and wrapped by hand, using the same material used for the pipe with the same number of applications of each material carefully and smoothly applied.

2.2.4.2 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.3 JOINTS

2.3.1 Plastic Pipe

2.3.1.1 Polyvinyl Chloride 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 as approved by the Contracting Officer.

2.3.2 RPMP Pipe

Joints shall be mechanical or bell and spigot type with elastomeric gasket.

2.3.3 RTRP

2.3.3.1 RTRP-I, Grade I and 2

Joints shall be bell and spigot with elastomeric gasket, mechanical coupling with elastomeric gasket, threaded and bonded coupling, or tapered bell and spigot with compatible adhesive. All RTRP-I materials shall be products of a single manufacturer.

2.3.3.2 RTRP-II, Grade 1 and 2

Joints shall be the bell and spigot type with elastomeric gasket, bell and spigot with adhesive, butt-jointed with adhesive bonded reinforced overlay, mechanical, flanged, threaded or commercially available proprietary joints, provided they are capable of conveying water at the pressure and temperature of the pipe.

2.3.4 Ductile-Iron Pipe

a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.

b. Push-on joints shall conform to AWWA C111.

c. Rubber gaskets and lubricant shall conform to the applicable

requirements of AWWA C111.

2.3.5 Steel Pipe

2.3.5.1 Steel Pipe, Not Galvanized

a. Mechanical couplings shall be as hereinafter specified.

b. Bell-and-spigot joints for use with rubber gaskets shall conform to AWWA C200, as appropriate for the type of pipe. Rubber gaskets shall conform to applicable requirements of AWWA C200.

c. Flanges shall conform to AWWA C207, and shall be used only in above ground installation or where shown on the drawings, or when approved.

2.3.5.2 Mechanical Couplings

Mechanical couplings for steel pipe shall be the sleeve type, or when approved, the split-sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

2.3.6 Bonded Joints

For all ferrous pipe, a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

2.3.7 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.4 VALVES

2.4.1 Gate Valves

Gate valves shall be designed for a working pressure of not less than 1.03

MPa (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 80 mm (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 80 to 300 mm (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 80 mm (3 inches) through 250 mm (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 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 will 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 5 mm. 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 VALVE PITS

Valve pits shall be constructed at locations indicated or as required above and in accordance with the details shown. Concrete shall have compressive strength of 21 MPa in accordance with Section 03300CONCRETE FOR BUILDING CONSTRUCTION.

2.7 FIRE HYDRANTS

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 125 mm (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 200 mm above the ground grade . Hydrants shall have a 150 mm (6 inch) bell connection, two 65 mm (2-1/2 inch) hose connections and one 115 mm (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 similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and two 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 each outlet, with caps, shall be furnished.

2.8 MISCELLANEOUS ITEMS

2.8.1 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 1.375 MPa (200 psi).

2.8.2 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable-iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of [1.03 MPa ([_____] psi)] [[_____] MPa ([_____] 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. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters (50 foot-pound).

2.8.3 Service Boxes

Service boxes shall be cast iron or 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 sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

2.8.4 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. 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 3 m from a sewer except where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least 3 m each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm above the sewer main. Joints in the sewer main, closer horizontally than 900 mm 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 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes.

3.1.3 Joint Deflection

3.1.3.1 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 in no case shall it exceed 5 degrees.

3.1.3.2 Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.1.3.3 Steel Pipe

For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves,

horizontal curves, or offsets shall be 5 degrees unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

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. Under no circumstances shall any of the water-line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. 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 the Contractor at his 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 Plastic Pipe Installation

RTRP shall be installed in accordance with ASTM D 3839. RPMP shall be installed in accordance with the recommendations of the manufacturer. PVC pipe shall be installed in accordance with AWWA M23.

3.1.4.2 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-01.

3.1.4.3 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.

3.1.4.4 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.5 Jointing

3.1.5.1 Polyvinyl Chloride (PVC) Plastic Pipe

a. Pipe less than 100 mm (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 requirements of ASTM F 477 and as required herein. All 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 the requirements of 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 100 mm (4 inch) through 300 mm (12 inch) diameter: Joints shall be elastomeric-gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm (4 inch) diameter with configuration using elastomeric ring gasket.

c. Pipe 350 mm (14 inch) through 900 mm (36 inch) diameter: Joints shall be elastomeric-gasket push-on joints made in accordance with AWWA M23.

3.1.5.2 RTRP I, RTRP II and RPMP Pipe

a. RTRP I: Assembly of the pipe shall be done in strict conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved nor shall additional joints be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged. Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 10.3 MPa (1,500 psi) or greater when carried out in accordance with ASTM D 1599. All field bonded epoxy-cemented joints, regardless of ambient temperature, shall be cured with a self-regulating thermostatically temperature controlled electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Contracting Officer. The joint sections shall not be moved during heating or until the joint has cooled to ambient temperature.

b. RTRP II: A reinforced overlay joint shall be used to join sections together through a placement of layers of reinforcement

fiberglass roving, mat, tape or fabric thoroughly saturated with compatible catalyzed resin.

c. Fittings and Specials for RTRP and RPMP Pipe: Metal to RTRP and RPMP pipe connections shall be made by bolting steel flanges to RTRP and RPMP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat-faced type. Where raised-face steel flanges are used, spacer rings shall be used to provide a flat-face seat for RTRP and RPMP pipe flanges. A full-face Buna "N" gasket 3.2 mm (1/8 inch) thick with a shore hardness of 50-60 shall be used between all flanged connections. The RTRP and RPMP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on RTRP and RPMP pipe flanges. Bolts and nuts shall be of noncorrosive steel and torqued to not more than 135 Newton meters. Flanges shall not be buried. A concrete pit shall be provided for all flanged connections.

3.1.5.3 Ductile-Iron Pipe

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

3.1.5.4 Steel Pipe, Not Galvanized

a. Mechanical Couplings: Mechanical couplings shall be installed in accordance with the recommendations of the couplings manufacturer.

b. Rubber Gaskets: Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the recommendations of the pipe manufacturer.

3.1.5.5 Bonded Joints

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

3.1.5.6 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

3.1.5.7 Connections

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 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 1.5 m outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 1.5 m 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 50 mm (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 80 mm (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 Field Coating and Lining of Pipe

3.1.7.1 Steel Pipe 80 mm (3 In.) and Larger, Not Galvanized

a. Cement-mortar coating and lining: Field jointing shall conform to Appendix, AWWA C205. Any defective area found in the coating and/or lining of pipe and joints shall be removed to the pipe wall and repaired. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe. Steel reinforcement in the coating shall be repaired or replaced as necessary to assure a complete and soundly reinforced coating.

b. Coal-tar enamel coating, lining and wrapping: Field jointing shall conform to AWWA C203. The applied materials shall be tested by means of a spark-type electrical inspection device in accordance with the requirements of AWWA C203. Any flaws or holidays found in the coating and/or lining of pipe and joints shall be repaired by patching or other approved means. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe.

3.1.8 Setting of Fire Hydrants, Valves and Valve Boxes

3.1.8.1 Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 150 mm (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 450 mm above the finished surrounding grade, and the operating nut not more than 1.2 m above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 450 mm above the finished surrounding grade, the top of the hydrant not more than 600 mm above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished gradeline 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 100 mm thick and 400 mm square. Not less than 2 cubic meters of free-draining broken stone or gravel shall be placed around and beneath the

waste opening of dry barrel hydrants to ensure drainage.

3.1.8.2 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 carefully tamped around each valve box or pit to a distance of 1.2 m on all sides of the box, or the undisturbed trench face if less than 1.2 m.

3.1.8.3 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.

3.1.9 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.1.10 Thrust Restraint

Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, on waterlines 100 mm (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.

3.1.10.1 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 14 MPa 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.

3.1.10.2 Restrained Joints

For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-01.

3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fitting 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 1.38 MPa (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 contract.

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 02222 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 1.38 MPa (200 psi) pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain pressure within 34.5 kPa (5 psi) of the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

L = 0.0001351ND(P raised to 1/2 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 satisfactory as specified. All 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 DISINFECTION

3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected [as prescribed by AWWA C651.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 must 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.

3.3.2 Lead Residual

Following the bacteriological disinfection and testing, the system shall be flushed with a sufficient velocity of water and sufficient tests performed at each hot- and cold-water discharge point until no more than 15 ppb lead residuals remain in the system. All tests and samples shall be performed in accordance with state and, if applicable, Federal regulations. Samples for testing are to be collected after a 6-hour continuous period of no flushing, and will be considered first draw samples. The commercial laboratory must be certified by the state's approving authority for examination of potable water. Lead residual test results are to be submitted to the Contracting Officer. The system will not be accepted

until satisfactory bacteriological results and lead residual test results have been obtained. All flushing and testing for lead residuals, including all costs, are the responsibility of the Contractor.

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 --

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SECTION 02685

GAS DISTRIBUTION SYSTEM

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-01	(1989) A.G.A. Plastic Pipe Manual for Gas Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B109.2	(1992) Diaphragm Type Gas Displacement Meters (Over 500 Cubic Feet per Hour Capacity)

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(1995) Line Pipe
API Spec 6D	(1994; Supple June 1996) Pipeline Valves, (Gate, Plug, Ball, and Check Valves)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 181	(1995b) Forgings, Carbon Steel, for General-Purpose Piping
ASTM D 2513	(1995c) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D 2517	(1994) Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
ASTM D 2683	(1993) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 3261	(1993) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM D 3350	(1993) Polyethylene Plastics Pipe and

Fittings Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1988; Errata Oct 1988; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B16.40	(1985; R 1994) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions

NACE INTERNATIONAL (NACE)

NACE RP0185	(1985) Extruded, Polyolefin Resin Coating Systems for Underground or Submerged Pipe
NACE RP0274	(1993) High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

STEEL STRUCTURES PAINTING COUNCIL (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)
SSPC Paint 101	(1991) Aluminum Alkyd Paint
SSPC Paint 104	(1991) White or Tinted Alkyd Paint
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL-06	(1996) Gas and Oil Equipment Directory

1.2 GENERAL REQUIREMENTS

1.2.1 Welding Steel Piping

Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

1.2.2 Jointing Polyethylene and Fiberglass Piping

Piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA-01. Manufacturer's prequalified joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA-01. Joiners and inspectors shall be qualified at the jobsite by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA-01. The Contracting Officer shall be notified at least 24 hours in advance of the date to qualify joiners and inspectors.

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. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. 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.

1.2.5 Handling

Pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Plastic pipe shall be handled in conformance with AGA-01.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Pipe, Fittings, and Associated Materials; FIO.

Drawings shall contain complete schematic and piping 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 the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-07 Schedules

Equipment and Materials; FIO.

A complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

a. Dielectric Unions and Flange Kits.

b. Meters.

c. Pressure Reducing Valves.

d. Regulators.

e. Emergency Gas Supply Connection.

Spare Parts Data; FIO.

Spare parts lists for each different item of material and equipment specified, after approval of the detail drawings and not later than [3] 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.

Notification; FIO.

Notification of the Contractor's schedule for making connections to existing gas lines, at least 10 days in advance.

SD-08 Statements

Welding Steel Piping; FIO.

A copy of qualified welding procedures along with a list of names and identification symbols of performance qualified welders and welding operators.

Jointing Polyethylene and Fiberglass Piping; GA.

A copy of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors.

Connection and Abandonment Procedures; GA.

A copy of procedures for gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in accordance with ASME B31.8.

SD-13 Certificates

Utility Work; FIO.

Certification from the Operating Agency/Utility Company that work for which the Utility is responsible has been completed.

Training; FIO.

A copy of each inspector's and jointer's training certificate with respective test results.

SD-19 Operation and Maintenance Manuals

Gas Distribution System; FIO.

[Six] copies, in booklet form and indexed, of site specific natural gas operation and maintenance manual for each gas distribution system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

The System Operation Manual shall include but not be limited to the following:

a. Maps showing piping layout and locations of all system valves and gas line markers.

b. Step-by-step procedures required for system startup, operation, and shutdown. System components and equipment shall be indexed to the gas maps.

c. Isolation procedures and valve operations to shut down or isolate each section of the system. Valves and other system components shall be indexed to the gas maps.

d. Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning gas piping and system components.

e. Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to gas map, recommended emergency equipment, checklist for major emergencies and procedures for connecting emergency gas supply.

The Equipment Operation Manual shall include but not be limited to detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment, valves and system components.

The System Maintenance Manuals shall include but not be limited to:

a. Maintenance check list for entire gas distribution system.

b. Descriptions of site specific standard maintenance procedures.

c. Maintenance procedures for installed cathodic protection systems.

d. Piping layout, equipment layout, and control diagrams of the systems as installed.

e. Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

The Equipment Maintenance Manuals shall include but not be limited to the following:

a. Identification of valves and other equipment by materials, manufacturer, vendor identification and location.

b. Maintenance procedures and recommended maintenance tool kits for all valves and equipment.

c. Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.

d. Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

PART 2 PRODUCTS

2.1 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

2.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Grade A or B, Type E or S, Schedule 40; or API Spec 5L seamless or electric resistance welded, Schedule 40, black steel pipe as specified in ASME B31.8. Furnace buttwelded pipe may be used in sizes 40 mm (1-1/2 inches) and smaller.

2.1.2 Small Fittings

Fittings 40 mm (1-1/2 inches) and smaller shall conform to ASME B16.11.

2.1.3 Steel Forged Branch Connections

Connections shall conform to ASTM A 181, Class 60, carbon steel.

2.1.4 Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm (1/16 inch) minimum thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluorethylene, suitable for maximum 315 degrees C service and meeting applicable requirements of ASME B31.8.

2.1.5 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.6 Polyethylene Pipe, Tubing, Fittings and Joints

Polyethylene pipe, tubing, fittings and joints shall conform to ASTM D 3350 and ASTM D 2513, pipe designations PE 2406 and PE 3408, rated SDR [11] or less, as specified in ASME B31.8. Pipe sections shall be marked as required by ASTM D 2513. Butt fittings shall conform to ASTM D 3261 and socket fittings shall conform to ASTM D 2683. Fittings shall match the service rating of the pipe.

2.1.7 Fiberglass Pipe, Fittings and Adhesive

Fiberglass pipe, fittings and adhesive shall conform to ASTM D 2517. Pipe sections shall be marked as required by ASTM D 2517.

2.1.8 Sealants for Steel Pipe Threaded Joints

2.1.8.1 Sealing Compound

Joint sealing compound shall be as listed in UL-06, Class 20 or less.

2.1.8.2 Tape

Polytetrafluoroethylene tape shall conform to ASTM D 3308.

2.1.9 Identification

Pipe flow markings and metal tags for each valve, meter, and regulator shall be provided as required by the Contracting Officer.

2.1.10 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing steel and polyethylene or fiberglass pipe. Approved transition fittings are those that conform to AGA-01 requirements for transition fittings.

2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Steel Valves

Steel valves 40 mm (1-1/2 inches) and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends, with square wrench

operator adaptor. Steel valves 40 mm (1-1/2 inches) and smaller installed aboveground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator.

2.2.2 Polyethylene Valves

Polyethylene valves shall conform to ASME B16.40. Polyethylene valves, in sizes 15 mm to 150 mm (1/2 inch to 6 inches), may be used with polyethylene distribution and service lines, in lieu of steel valves, for underground installation only.

2.3 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.

2.3.1 Service Line 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 2.5 kPa (10 inches of water column). Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulators for liquified petroleum gas shall be adjusted to 2.5 to 3 kPa (10 to 12 inches of water column). Pressure relief for liquified petroleum gas shall be set at 4 kPa (16 inches of water column). Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 50 mm (2 inch) size.

2.4 METERS

Meters shall conform to ANSI B109.2. Meters shall be pedestal]mounted and be provided with a strainer immediately upstream. Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 2.83 cubic meter (100 cubic feet) of gas.

2.5 PROTECTIVE COVERING MATERIALS

2.5.1 Thermoplastic Resin Coating System

Continuously extruded polyethylene and adhesive coating system materials shall conform to NACE RP0185, Type A.

2.6 TELEMETERING OR RECORDING GAUGES

Each distribution system supplied by more than one district pressure regulating station shall be equipped with telemetering or recording pressure gauges to indicate the gas pressure in the district line.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2 SERVICE LINES

Service lines shall be constructed of materials specified for gas mains and shall extend from a gas main to and including the point of delivery within 1.5 meters (5 feet) of the building. The point of delivery is the meter set assembly. The service lines shall be connected to the gas mains as indicated. Where indicated, service line shall be provided with an isolation valve of the same size as the service line. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few joints as practicable using standard lengths of pipe. Shorter lengths shall be used only for closures. Polyethylene or fiberglass service lines shall not be installed aboveground except as permitted in ASME B31.8.

3.3 WORKMANSHIP AND DEFECTS

Pipe, tubing, and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and blown free of chips and scale. Defective pipe, tubing, or fittings shall be replaced and shall not be repaired.

3.4 PROTECTIVE COVERING

3.4.1 Protective Covering for Underground Steel Pipe

Except as otherwise specified, protective coverings shall be applied mechanically in a factory or field plant especially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant that applies the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in thickness to that of the covering applied mechanically.

3.4.1.1 Thermoplastic Resin Coating System

The coating system shall conform to NACE RP0185, Type A. The exterior of the pipe shall be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6. Adhesive compound shall be applied to the pipe. Immediately after the adhesive is applied, a seamless tube of polyethylene shall be extruded over the adhesive to produce a bonded seamless coating. The nominal thickness of the pipe coating system shall be 0.25 mm (10 mils)

(plus or minus 10 percent) of adhesive and 1.0 mm (40 mils) (plus or minus 10 percent) of polyethylene for pipes up to 400 mm (16 inches) in diameter. For pipes 450 mm (18 inches) and larger in diameter, the pipe coating system thickness shall be 0.25 mm (10 mils) (plus or minus 10 percent) adhesive and 1.5 mm (60 mils) (plus or minus 10 percent) polyethylene. Joint coating and field repair material shall be applied as recommended by the coating manufacturer and shall be one of the following:

a. Heat shrinkable polyethylene sleeves.

b. Polyvinyl chloride pressure-sensitive adhesive tape.

c. High density polyethylene/bituminous rubber compound tape.

The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

3.4.1.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current set at a value in accordance with NACE RP0274 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

3.4.2 Protective Covering for Aboveground Piping Systems

Finish painting shall conform to the applicable paragraphs of Section 09900 PAINTING, GENERAL and as follows:

3.4.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer same type paint as the shop primer. Surfaces that have not been shop primed shall be solvent-cleaned in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing in accordance with SSPC SP 3 or brush-off blast cleaned in accordance with SSPC SP 7 and primed with ferrous metal primer in accordance with SSPC Paint 25. Primed surfaces shall be finished with two coats of exterior alkyd paint conforming to SSPC Paint 104.

3.4.2.2 Nonferrous Surfaces

Nonferrous surfaces shall not be painted.

3.4.3 Protective Covering for Piping in Valve Boxes and Manholes

Piping in valve boxes or manholes shall receive protective coating as specified for underground steel pipe.

3.5 INSTALLATION

Gas distribution system and equipment shall be installed in conformance with the manufacturer's recommendations and applicable sections of ASME B31.8, AGA-01 and 49 CFR 192. Abandoning existing gas piping shall be done in accordance with ASME B31.8. Pipe shall be cut without damaging 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 150 mm (6 inches and larger, an approved gas-cutting-and-beveling machine may be used. Cutting of plastic pipe shall be in accordance with AGA-01. Valve installation in plastic pipe shall be designed to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box.

3.5.1 Installing Pipe Underground

Service lines shall be graded as indicated. Joints in steel pipe shall be welded except as otherwise permitted for installation of valves.Service lines shall have 485 mm minimum cover and service lines shall be placed on firmly compacted select material for the full length. Trench shall be excavated below pipe grade, bedded with bank sand, and compacted to provide full-length bearing. Laying the pipe on blocks to produce uniform grade will not be permitted. The pipe shall be clean inside before it is lowered into the trench and shall be kept free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, open ends of pipe or fittings shall be securely closed by expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved. Changes in line or gradient that exceed the limitations specified shall be made with fittings. When cathodic protection is furnished, electrically insulated joints or flanges shall be provided. When polyethylene or fiberglass piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector. After laying of pipe and testing, trench shall be backfilled in accordance with Section 02222EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITY SYSTEMS.

3.5.2 Installing Pipe Aboveground

Aboveground piping shall be protected against dirt and other foreign matter as specified for underground piping. Joints in steel pipe shall be welded; however joints in pipe 40 mm (1-1/2 inches) in diameter and smaller may be threaded; joints may also be threaded to accommodate the installation of valves. Flanges shall be of the weld neck type to match wall thickness of pipe.

3.6 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pullout forces caused by the contraction of piping or superimposed loads.

3.6.1 Threaded Steel Joints

Threaded joints in steel pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or polytetrafluoroethylene tape applied to the male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.

3.6.2 Welded Steel Joints

Gas 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 B31.8. 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.

3.6.3 Polyethylene and Fiberglass Pipe Jointing Procedures

Jointing procedures shall conform to AGA-01. Indiscriminate heat fusion joining of plastic pipe or fittings made from different polyethylene resins by classification or by manufacturer shall be avoided if other alternative joining procedures are available. If heat fusion joining of dissimilar polyethylenes is required, special procedures are required. The method of heat fusion joining dissimilar polyethylene resins shall be tested in accordance with paragraph TESTS, subparagraph Destructive Tests of Plastic Pipe Joints.

3.6.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

3.7 VALVE BOXES

Valve boxes of cast iron not less than 4.7 mm (3/16 inch) thick shall be installed at each underground valve except where concrete or other type of housing is indicated. Valve boxes shall be provided with locking covers that require a special wrench for removal. Wrench shall be furnished for each box. The word "gas" shall be cast in the box cover. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 1 square meter. When in a sidewalk, the top of the box shall be in a concrete slab 600 mm square and set flush with the sidewalk. Boxes shall be adjustable extension type with screw or slide-type adjustments. Valve boxes shall be separately supported, not resting on the pipe, so that no traffic loads can be transmitted to the pipe. Valves shall only be located in valve boxes or inside of buildings.

3.8 PRESSURE REGULATOR INSTALLATION

3.8.1 Service Line Regulators

A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 450 mm above the ground on the riser. An insulating joint shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 10 mm (3/8 inch) tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the

regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

3.9 METER INSTALLATION

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.10 CONNECTIONS TO EXISTING LINES

Connections between new work and existing gas lines, where required, shall be made in accordance with ASME B31.8 using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fittings shall be the same size as the pipe being connected.

3.10.1 Connection to Government Owned/Operated Gas Lines

The Contractor shall provide connections to the existing gas lines in accordance with approved procedures. Deactivation of any portion of the existing system shall only be done at the valve location shown on the drawings. Reactivation of any existing gas lines will only be done by the Government. The Contractor's Connection and Abandonment Plan shall be submitted and approved prior to making any connections to existing gas lines. This plan shall include the Operating Agency's required procedures which may be obtained from [the base civil engineer]. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

a. If facilities are abandoned in place, they shall be physically disconnected from the piping system. The open ends of all abandoned facilities shall be purged, capped, plugged or otherwise effectively sealed. Abandonment shall not be completed until it has been determined that the volume of gas or liquid hydrocarbons contained within the abandoned section poses no potential hazard. Air or inert gas may be used for purging, or the facility may be filled with water or other inert material. If air is used for purging, the Contractor shall ensure that a combustible mixture is not present after purging.

b. When a main is abandoned, together with the service lines connected to it, only the customer's end of such service lines is required to be sealed as stipulated above.

c. Service lines abandoned from the active mains shall be disconnected as close to the main as practicable.

d. All valves left in the abandoned segment shall be closed.

e. All abovegrade valves, risers, and vault and valve box covers shall be removed. Vault and valve box voids shall be filled with suitable compacted backfill material.

3.11 CATHODIC PROTECTION

Cathodic protection shall be provided for all metallic gas piping installed

underground and shall be installed as specified in [Section 16640CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 16642 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

3.12 TESTS

3.12.1 Destructive Tests of Plastic Pipe Joints

Each day, prior to making polyethylene heat fusion joints or fiberglass adhesive joints, a joint of each size and type to be installed that day shall be made by each person performing joining of plastic pipe that day and destructively tested. At least 3 longitudinal straps shall be cut from each joint. Each strap shall be visually examined, shall not contain voids or discontinuities on the cut surfaces of the joint area, and shall be deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint shall not make further field joints in plastic pipe on this job until that person has been retrained and requalified. The results of the destructive tests shall be recorded to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

3.12.2 Pressure and Leak Tests

The system of gas mains and service lines shall be tested after construction and before being placed in service using air as the test medium. The normal operating pressure for the system is 30. The test pressure is 60. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials. Testing of gas mains and service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. Joints in sections shall be tested prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.

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SECTION 02698

PREFABRICATED UNDERGROUND COOLING DISTRIBUTION SYSTEM

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	(1995b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105	(1996) Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1994) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 234	(1996b) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
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	(1994) Corrosion Test for Engine Coolants in Glassware
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2241	(1994) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 3139	(1989; R 1995) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

ASTM D 5686	(1995) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Pipe Fittings, Adhesive Bonded Joint Type Epoxy Resin, for Condensate Return Lines
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

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	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1995) Power Piping
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA-02	(1995) Copper Tube Handbook

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-73	(1991) 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 150 mm 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 500 kPa and an operating temperature of 7 degrees C for chilled water.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Distribution System; FIO.

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-04 Drawings

Distribution System; FIO.

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-13 Certificates

Distribution System; FIO.

The manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification.

Welding Procedures and Operators; FIO.

Prior to welding operations, a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-19 Operation and Maintenance Manuals

Distribution System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished, one 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. All 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. Any 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. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

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.

2.2.2.3 Reinforced Thermosetting Resin Pipe (RTRP)

RTRP pipe shall conform to ASTM D 5686.

2.2.2.4 Polyvinyl Chloride (PVC) Pipe

PVC pipe shall conform to ASTM D 2241 with a Standard Thermoplastic Pipe Dimension Ratio (SDR) of 26 and PVC 1120 or 1220 as the material.

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 one-hundredth the diameter of the casing or 1.50 mm.

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 mm)	Minimum Thickness (in mm)
250 and smaller	3
250 to 450	4
450 to 600	5
over 600	6

2.2.3.3 Reinforced Thermosetting Resin Pipe (RTRP) Casing

RTRP casing shall be of the same material as designated for the pipe with casing thickness as follows:

Casing Diameter (in mm)	Minimum Thickness (in mm)
200 and smaller	1.2
250	2
300	2.7
350	2.9
400 to 450	3
500	3.2
600	3.9

2.3 PIPING CONNECTIONS

2.3.1 Steel Pipe

Steel pipe smaller than 20 mm may be threaded, otherwise, all steel pipe shall be welded. Steel welding fittings shall conform to the requirements of ASTM A 105 or ASTM A 234. Welding fittings shall also conform to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Long radius buttwelding 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.

2.3.3 Plastic Pipe

a. Pipe, fittings, flanges, and couplings shall have end connections of the adhesive bell and spigot type. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.

b. Flanged Connections: Flat face flanged connections shall be provided between plastic piping and metal piping. Plastic flanges shall be suitable for connection to ASME Class 150 flanges.

c. RTRP Piping Sizes: When piping sizes other than 50, 75, 100, 150, and 200 mm are indicated, the next larger piping size shall be provided. The connecting system piping shall be of the same size or increased to meet the next size of RTRP piping.

2.3.3.1 General

Plastic fittings shall be made of the same type and grade of material as the piping to which they will be connected and shall be furnished by the manufacturer who supplies the pipe. Fittings shall have temperature and pressure ratings not less than those of the connecting piping.

2.3.3.2 Polyvinyl Chloride (PVC)

Polyvinyl chloride (PVC) pipe shall be solvent welded or connected using bell and spigot connections. The solvent used to connect fittings and pipe shall conform to the requirements of ASTM D 2564. Bell and spigot joints utilizing elastomeric seals shall conform to the requirements of ASTM D 3139. The elastomeric seals shall conform to ASTM F 477.

2.3.3.3 Reinforced Thermosetting Resin Plastic (RTRP)

Reinforced thermosetting resin plastic pipe shall be joined using fittings and adhesive furnished by the pipe manufacturer in accordance with ASTM D 5686.

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 40 mm 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 5 degrees C shall circulate through the carrier pipe alternating every 24-hours with a fluid with a temperature of 95 degrees C circulating through the carrier pipe for a low temperature hot water or dual temperature service or 24 degrees 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 300 mm of sand all around the test sample. The carrier pipe size of the test sample shall be 80 mm 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 60 kPa subjected over the entire length of the 2.4 m 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. A pipe manufacturer who has a current Federal Letter of Acceptability for a system furnished under this section will be exempt from the testing specified in this paragraph.

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 32 kg per cubic meter. The polyurethane foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of 20 mm. The insulation thermal conductivity factor shall not exceed the numerical value of 0.02 W/mK at 24 degrees C, 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 1.3 mm shall be provided over casing connection joints.

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.

3.3 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 14 MPa 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 300 mm 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 40 mm in 1 m 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 three 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-02. Brazing alloys melting above 593.3 degrees C shall be utilized.

3.4.4.4 Nonmetallic Pipe Joints

Nonmetallic pipe joints shall be installed in accordance with the written instructions of the manufacturer.

3.4.5 Expansion Loops

Expansion loops shall be factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Loops shall be properly designed in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used. Loops shall be shipped to the jobsite in the maximum size sections feasible to minimize the number of field joints. The loop casing and insulation where applicable, shall be suitably sized to accommodate pipe movement. Field joints shall be made in straight runs of the loops and the number shall be kept to a minimum. For

steel pipe, cold springing shall not be allowed when sizing the expansion loops, but piping shall be cold sprung one-half the calculated maximum operational expansion during field assembly. L- and Z-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 150 mm 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 300 mm deep. Tape shall be polyethylene tape with metallic core. Tape shall be 150 mm 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.

3.5 EARTHWORK

Earthwork shall be performed in accordance with Section 02222EXCAVATION, 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 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.

3.7.1.1 Cleaning Carrier Pipe

Prior to testing, the interior of the carrier pipe shall be cleaned of all foreign materials by thorough flushing with clean water. Water shall be circulated at a velocity between 2 and 3 m/s for a minimum of 4 hours. If required, temporary and/or supplementary pumps shall be provided to ensure that required velocity is achieved. Any system strainers shall be cleaned after the flushing operation is complete. Temporary strainers shall be installed as required. After flushing, the water will remain in the piping system for testing of the system. All air must be removed from the system prior to starting the tests.

3.7.1.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure cycling will have four cycles. Each cycle shall consist of a 10 minute period at 1,000 kPa followed by a 5 minute period at a pressure less than 350 kPa. The next cycle will begin immediately following the completion of the previous cycle. Pressure rise and drop shall not exceed 690 kPa 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 1,000 kPa. 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.

3.7.1.3 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 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.

3.7.1.4 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 1000 kPa. This pressure shall be held for a minimum of 4 hours. The method of pressurizing the system shall be disconnected from the system 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.

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SECTION 02720

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SECTION 02720

STORM-DRAINAGE SYSTEM

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 346/346R	(1990) Standard Specification for Cast-in-Place Nonreinforced Concrete Pipe and Recommendations

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-16	(1996) Standard Specifications for Highway Bridges
AASHTO M 167	(1994) Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe
AASHTO M 190	(1988) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 198	(1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 219	(1992) Aluminum Alloy Structural Plate for Field Bolted Conduits
AASHTO M 243	(1994) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 294	(1994) Corrugated Polyethylene Pipe, 305- to 915- mm 12-to 36 in. Diameter
AASHTO M 304	(1994) Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

.

AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)

AREA-03	(1994) Manual for Railway Engineering (Fixed Properties): Chapter 1, Roadway and Ballast

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 444	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Storm Sewer and Drainage Pipe
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 716	(1995) Ductile Iron Culvert Pipe
ASTM A 742	(1993) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760	(1995a) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762	(1995) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798	(1994) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 807	(1996) Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 849	(1994) Post Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B 26	(1996) Aluminum-Alloy Sand Castings
ASTM B 745	(1995) Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 12	(1995) Installing Vitrified Clay Pipe Lines
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 32	(1993) Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55	(1995) Concrete Building Brick
ASTM C 62	(1996) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76	(1995) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 139	(1995) Concrete Masonry Units for Construction of Catch Basins and Manholes

ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1996a) Mortar for Unit Masonry
ASTM C 425	(1995) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1994) Precast Reinforced Concrete Manhole Sections
ASTM C 506	(1995) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 507	(1995a) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 655	(1994) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 700	(1996) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 789	(1994) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 850	(1994) 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 D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
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 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 1784	(1992) 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	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1993) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(1994) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Placing Pipe; FIO.

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-13 Certificates

Resin Certification; FIO. Pipeline Testing; FIO.
Determination of Density; FIP. Frame and Cover for Gratings; FIO.

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. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

1.3.2 Handling

Materials shall be handled in such a manner as to ensure delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR 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.

2.1.2 Clay Pipe

Standard or extra strength, as indicated, conforming to ASTM C 700.

2.1.3 Corrugated Aluminum Alloy Pipe

ASTM B 745 corrugated aluminum alloy pipe of:

a. Type I pipe with helical corrugations.

2.1.4 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe in accordance with AASHTO M 304, shall be submitted prior to installation of the pipe.

2.1.4.1 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.

2.1.4.2 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.

2.1.4.3 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.

2.1.4.4 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.

2.1.5 PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.5.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 80 to 600 mm in diameter and maximum DR of 26 for pipes 650 to 1200 mm in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

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 444.

2.2.2 Precast Reinforced Concrete Box

For highway loadings with 600 mm of cover or more or subjected to dead load only, ASTM C 789; for less than 600 mm 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 21 MPa concrete under Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. 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 37.5 mm. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 25 mm thick for covers and not less than 40 mm thick for walls and

flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 75 mm 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 shall conform to ASTM C 270, Type M, except 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 24liters (6 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 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, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.3.4 Joints

2.3.4.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.35 m (54 inches).

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished if specifically approved.

2.3.4.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.3.4.3 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.

2.3.4.4 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.4 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.4.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

2.4.2 Corrugated Aluminum Pipe

A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-16 (Division II, Section 26). The pipe will be supported for the hydrostatic test so that the joint is located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in meters (feet) for the pipe flowing full or 54,233 Newton meters (40,000 foot-pounds), whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 69 kPa (10 psi) for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

PART 3 EXECUTION

3.1 EXCAVATION FOR 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 02222 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 600 mm 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. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall 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

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe for the entire length of the pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making the particular type of joint.

3.2.2 Clay Pipe

Bedding for clay pipe shall be as specified by ASTM C 12.

3.2.3 Corrugated Metal Pipe

Bedding for corrugated metal pipe shall be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807.

3.2.4 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 carefully examined before being laid, and defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to the direct sunlight prior to laying as needed 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. Under no circumstances shall pipe be laid in water, and no pipe shall 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 plastic pipe shall not exceed 4.5 percent of the nominal inside diameter. After backfilling has been completed, the Government may perform a deflection test on the entire length of installed plastic pipeline using a mandrel or other suitable device. Any plastic pipe showing deflections in excess of 4.5 percent shall be removed and replaced at the Contractor's expense. All pipe in place shall be inspected before

backfilling, and those pipes damaged during placement shall be removed and replaced.

3.3.1 Concrete, Clay, and PVC Pipe

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.

3.3.2 Corrugated Metal Pipe

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.4 JOINTS

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 carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as 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 then 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 then 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 such lengths that they will 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 200 mm 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 only the high side of band, 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 carefully forced out by pouring and removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall then 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 carefully 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 carefully 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 then 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 15 mm, thick and the width of the diaper band shall be at least 200 mm. 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. No backfilling around the joints shall 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 will be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above shall be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

3.4.2 Corrugated Metal Pipe

3.4.2.1 Field Joints

Transverse field joints shall be of such design that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the

size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall then be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket shall be closely observed to see that it is seating properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

3.5.1 Inlets

Construction shall be of reinforced concrete, precast reinforced concrete complete with frames and covers or gratings.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 BACKFILLING

3.6.1 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 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. Care shall be taken to ensure thorough compaction of the fill 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 300 mm 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 200 millimeters. Tests for density will be made as necessary to ensure conformance to the compaction requirements specified elsewhere in this paragraph. Where it is necessary in the opinion of the Contracting Officer, any sheeting or portions of bracing used shall be left in place and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.6.2 Movement of Construction Machinery

In 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 storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.6.3 Compaction

3.6.3.1 General

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.

3.6.3.2 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 (densities) which will be determined as specified in this paragraph.

a. Under paved roads, 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.

3.6.4 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. 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.

3.7 PIPELINE TESTING

Lines shall be tested for leakage by exfiltration tests. Prior to testing for leakage 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 600 mm 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 600 mm 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 0.98 liters per mm in diameter per kilometers (0.2 gallons per inch in diameter per 100 feet) of pipeline per hour. 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.

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SECTION 02730

SANITARY SEWERS

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 RAILWAY ENGINEERING ASSOCIATION (AREA)

AREA-03	(1994) Manual for Railway Engineering (Fixed Properties): Chapter 1, Roadway and Ballast

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1994) Cast Iron Soil Pipe and Fittings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 33	(1993) Concrete Aggregates
ASTM C 76	(1995) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 94	(1995) Ready-Mixed Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 270	(1995a) Mortar for Unit Masonry
ASTM C 425	(1995) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1994) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1994) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 564	(1995) Rubber Gaskets for Cast Iron Soil

	Pipe and Fittings
ASTM C 700	(1995) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(1990) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924	(1989) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 972	(1982; R 1990) Test Method for Compression-Recovery of Tape Sealant
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 624	(1991) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2680	(1995)Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2751	(1993) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3262	(1993) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D 3350	(1993) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3753	(1981; R 1991) Glass-Fiber-Reinforced Polyester Manholes
ASTM D 3840	(1988) "Fiberglass" (Glass-Fiber-Reinforced

	Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 477	(1993) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 714	(1994) Polyethylene (PE) Plastic pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1993a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
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	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1988) Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325M	(1991) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1990) Identification of the Fire Hazards of Materials

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the

	Low-Pressure Air Testing of Installed Sewer Pipe
UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

1.2 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 1.5 m 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 02222 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.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Portland Cement; FIO.

Certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes.

PART 2 PRODUCTS

2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Plastic Pipe

Acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D 2680.

2.1.1.1 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 380 mm (15 inch) or less in diameter. ASTM F 949 for corrugated sewer pipes with a smooth interior. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

2.1.3 Ductile Iron Pipe

Pipe shall conform to AWWA C151 unless otherwise shown or specified.

2.1.4 Cast Iron Soil Pipe

ASTM A 74, Class SV.

2.2 FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

2.2.1 Plastic Pipe

ABS and PVC composite sewer pipe fittings shall conform to ASTM D 2680.

2.2.1.1 PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

2.2.2 Ductile Iron Pipe

Mechanical fittings shall conform to AWWA C110, rated for 1.03 MPa (150 psi). Push-on fittings shall conform to AWWA C110and AWWA C111, rated for 10.3 MPa (150 psi).

2.2.3 Cast Iron Soil Pipe

ASTM A 74.

2.3 JOINTS

Joints installation shall comply with the manufacturer's instructions.

2.3.1 Plastic Pipe

Flexible plastic pipe (PVC or high density polyethylene pipe) gasketed joints shall conform to ASTM D 3212.

2.3.1.1 High Density Polyethylene Pipe

Rubber gasket joints shall conform to ASTM C 443.

2.3.2 RTRP

Joints shall be bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F 477.

2.3.3 Ductile Iron Pipe

Push-on joints shall conform to AWWA C111. Mechanical joints shall conform to AWWA C111 as modified by AWWA C151. Flanged joints shall conform to AWWA C115.

2.3.4 Cast Iron Soil Pipe

Rubber gaskets for compression joints shall conform to ASTM C 564. Packing material for caulked joints shall be twisted jute or oakum, tarred type, or asphalt-saturated cellulose-fiber. Joints for acid resisting cast iron soil pipe shall be made with acid resistant non-asbestos packing. The packing shall contain no material which would affect adhesion of the joint sealing material to the pipe. Lead shall be suitable for caulking of joints.

2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC composite pipe shall conform to Figure 2 of ASTM D 2680; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

2.5 FRAMES AND COVERS

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 as suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 181.4 kg (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.

2.6 STEEL LADDER

A steel ladder shall be provided where the depth of a manhole exceeds 3.6 m (12 feet). The ladder shall not be less than 406.4 mm (16 inches) in width, with 19.1 mm (3/4 inch) diameter rungs spaced 304.8 mm (12 inches) apart. The two stringers shall be a minimum 9.5 mm (3/8 inch) thick and 50.8 mm (2 inch) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123.

2.7 CEMENT MORTAR

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

2.7.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type II for concrete used manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking.

2.7.2 Portland Cement Concrete

Portland cement concrete shall conform to ASTM C 94, compressive strength of 28 MPa 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 17 MPa minimum at 28 days. Concrete

in place shall be protected from freezing and moisture loss for 7 days.

2.8 STRUCTURES

2.8.1 Precast Reinforced Concrete Manhole Sections

Precast reinforced concrete manhole sections shall conform to ASTM C 478, except that portland cement shall be as specified herein. Joints shall be cement mortar, an approved mastic, rubber gaskets, a combination of these types; or the use of external preformed rubber joint seals and extruded rolls of rubber with mastic adhesive on one side.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Adjacent Facilities

3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 3 m to a water-supply main or service line, except that where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, the horizontal spacing may be a minimum of 2 m. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 3 m on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 1 m to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 100 mm.

3.1.1.2 Roads, Railroads, and Airfields

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Where sleeves are required, in all other cases, the pipe sleeve shall be as specified for storm drains in Section 02720 STORM-DRAINAGE SYSTEM. A minimum clearance of at least 50 mm between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with the corrosion protection as required for the conditions encountered at the site of installation.

3.1.1.3 Structures

Where sewer pipe is to be installed within 1 m of an existing or proposed building or structural foundation such as a retaining wall, control tower footing, water tank footing, or any similar structure, the sewer pipe shall be sleeved as specified above. Care shall be exercised and proper precautions taken during installation of the sewer pipe and sleeve to assure that there will be no damage to such structures and no settlement or movement of foundations or footing.

3.1.2 Pipe Laying

a. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.

b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

c. Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted to obtain the degree of water tightness required.

d. Installations of solvent weld joint pipe, using PVC pipe and fittings shall be in accordance with ASTM F 402. All required precautions shall be taken to assure adequate trench ventilation and protection for workers installing the pipe.

3.1.2.1 Caulked Joints

The packing material shall be well packed into the annular space to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 25 mm after caulking.

3.1.2.2 Trenches

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings.

3.1.2.3 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

3.1.2.4 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, is exceeded for any reason other than by direction, the Contractor shall install at no additional cost to the Government such concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

3.1.2.5 Joints

Joints between different pipe materials shall be made as specified, using approved jointing materials.

3.1.2.6 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in UBPPA UNI-B-6. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 and ASTM C 924, after consultation with the pipe manufacturer. Prior to infiltration or 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 600 mm 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. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm 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 re-established. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 50 mL per 5 mm diameter per 100 meters of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

3.1.4 Test for Deflection

When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline not less than 30 days after the completion of all work including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 92.5 percent of the inside diameter of the pipe, but 95 percent for RPMP and RTRP. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4.0 degrees C (39.2 degrees F), and shall have a surface brinell hardness of not less than 150. It shall be center bored and through bolted with a 6.4 mm (1/4 inch) minimum diameter steel shaft having a yield strength of 480 MPa (70,000 psi) or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer such that a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be

so spaced that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water, shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections greater than 7.5 percent of the normal diameter of the pipe, or 5 percent for RTRP and RPMP, 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.

3.2 CONCRETE CRADLE AND ENCASEMENT

The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

3.3 WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.4 MANHOLES

3.4.1 General

Manholes shall be constructed of concrete or precast concrete manhole sections. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with brick and mortar, or shall be half tile laid in concrete, or shall be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. Pipe connections shall be made to manhole using water stops, standard O-ring joints, special manhole coupling, or shall be made in accordance with the manufacturer's recommendation. The Contractor's proposed method of connection, list of materials selected, and specials required, shall be approved prior to installation. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 100 mm per meter nor more than 200 mm per meter. Free drop inside the manholes shall not exceed 500 mm, measured from the invert of the inlet

pipe to the top of the floor of the manhole outside the channels, and drop manholes shall be constructed whenever the free drop would otherwise be greater than 500 mm.

3.4.2 Steel Ladder

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1850 mm apart vertically, and shall be installed to provide at least 150 mm of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.4.3 Jointing, Plastering and Sealing

Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Mortar and mastic joints between precast rings shall be full-bedded in jointing compound and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Installation of rubber gasket joints between precast rings shall be in accordance with the recommendations of the manufacturer. Precast rings may also be sealed by the use of extruded rolls of rubber with mastic adhesive on one side.

3.4.4 Frames and Covers

Unless otherwise indicated, tops of frames and covers shall be set flush with finished grade in paved areas or 50 mm higher than finished grade in unpaved areas. Frame and cover assemblies shall be sealed to manhole sections using external preformed rubber joint seals that meet the requirements of ASTM D 412 and ASTM D 624, or other methods specified in paragraph Jointing, Plastering and Sealing, unless otherwise specified.

3.4.5 External Preformed Rubber Joint Seals

External preformed rubber joint seals and extruded rolls of rubber with mastic adhesive shall meet the requirements of ASTM D 412 and ASTM C 972 to ensure conformance with paragraph Leakage Tests. The seal shall be multi-section with neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of 1.5 mm. Each unit shall consist of a top and a bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. One unit shall seal a casting and up to six, 50 mm adjusting rings. The bottom section will be 305 mm in height. A 152 mm high top section will cover up to two, 50 mm adjusting rings. A 305 mm high bottom section will cover up to six, 50 mm adjusting rings. Extension sections shall cover up to two more adjusting rings. Each extension shall overlap the bottom section by 50 mm and shall be overlapped by the top section by 50 mm.

3.5 CONNECTIONS TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made in such manner that the finish work will conform as nearly as practicable to the essential 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 1-1/2 times the diameter of the pipe. Cutting the manhole

shall be done in a manner that will cause the least damage to the walls.

3.6 BUILDING CONNECTIONS

Building connections shall include the lines to and connection with the building waste drainage piping at a point approximately 1.5 m outside the building, unless otherwise indicated. Where building drain piping is not installed, the Contractor shall terminate the building connections approximately 1.5 m from the site of the building at a point and in a manner designated.

3.7 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

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SECTION 02811

IRRIGATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

The irrigation design is not included in this design package. The Contractor shall provide the design and installation to achieve full irrigation coverage of all plantings and turf. Provide a complete automatic turf and pop-up bubbler irrigation system for all plantings as per specifications and details. Layout of circuits shall be clearly defined into hydrozones/microclimates with similar water requirements and precipitation rates. Ensure each plant receives the required amounts of water without over or under saturating other plants within the same circuit. The irrigation system shall be designed based on the static pressure at the backflow preventer at the time of installation. A pressure test shall be performed prior to the start of work. Design shall meet all local codes and regulations and shall operate properly within the acceptable use of all equipment used.

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1989a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B 32	(1989) Solder Metal
ASTM B 43	(1988) Seamless Red Brass Pipe, Standard Sizes
ASTM B 88	(1989) Seamless Copper Water Tube
ASTM D 1785	(1989) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1989) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2287	(1981; R 1988) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 2464	(1989) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1989) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1988) Solvent Cements for (Poly Vinyl

	Chloride) (PVC) Plastic Pipe and Fittings
ASTM D 2774	(1972; R 1983) Underground Installation of Thermostatic Pressure Piping
ASTM D 2855	(1983) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	(1988a) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM F 441	(1989) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.26.1M	(1984) Water Hammer Arresters
ASME B1.2	(1983) Gages and Gaging for Unified Inch Screw Threads
ASME B16.3	(1985) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.15	(1985) Cast Bronze Threaded Fittings, Classes 125 and 250
ASME B16.18	(1984) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B40.1	(1985) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012	(Sep 1978) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(Apr 1988) Reduced Pressure Principle Backflow Preventers
ASSE 1020	(Feb 1989) Pressure Vacuum Breaker, Assembly (Recommended for Outdoor Usage)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	(1987) Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewerage Systems
AWWA C901	(1988; Errata) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. Through 3 in., for Water Service

FEDERAL SPECIFICATIONS (FS)

FS 0-F-506	(Rev C) Flux, Soldering; Paste and Liquid
FS WW-H-001220	(Basic) Head, Sprinkler, (Underground Connected)
FS WW-S-610	(Rev B; Am 1) Sprinkler, Lawn, (Surface Connected)

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCHR-01	(Jun 1988; 8th Ed) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1985) Cast Iron Globe and Angle Valves - Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1988; Rev 1) Industrial Control Devices, Controllers and Assemblies
NEMA ICS 6	(1988; Rev 1) Enclosures for Industrial Control and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1990) National Electrical Code

1.3 PERFORMANCE REQUIREMENTS

System shall operate with a minimum water pressure of at connection to main.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Design Analysis and Calculations; GA.

Design analyses and pressure calculations verifying that system will provide the irrigation requirements.

Spare Parts; GA.

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.

SD-04 Drawings

Sprinkler System; GA.

Detail drawings showing all irrigation work including valves, backflow preventers, automatic controllers, bubbler heads, lateral and mainlines. Drawing shall include legends and 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, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers.

As-built Drawings which provide current factual information after construction showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work shall be included.

SD-09 Reports

Field Tests; GA.

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 control valves.

Operations & Maintenance Manuals; GA.

Six copies of operations 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.

SD-13 Certificates

Sprinkler System; GA.

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 manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the weather; excessive humidity and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants.

1.6 FIELD MEASUREMENTS

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

2.1.1 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. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each 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.

2.1.3 Extra Stock

The following extra stock shall be provided: Ten 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.

2.2 PIPING MATERIALS

2.2.1 Copper Tubing and Associated Fittings (Shall only used when connecting existing piping of similar material.

2.2.1.1 Fittings

Fittings shall conform to ASME B16.22 and ASME B16.18, solder joint. Solder shall conform to ASTM B 32 95-5 tin-antimony. Flux shall conform to FS 0-F-506, Type I.

2.2.2 Red Brass Pipe and Associated Fittings (Shall only used when connecting existing piping of similar material.)

2.2.2.1 Pipe

Pipe shall conform to requirements of ASTM B 43, regular.

2.2.2.2 Fittings

Fittings shall be Class 250, cast bronze threaded conforming to the requirements of ASME B16.15.

2.2.3 Galvanized Steel Pipe and Associated Fittings (Shall only used when connecting existing piping of similar material.)

2.2.3.1 Pipe

Pipe shall conform to requirements of ASTM A 53, Schedule 40.

2.2.3.2 Fittings

Fittings shall be Class 150 conforming to requirements of ASME B16.3.

2.2.4 Polyvinyl Chloride (PVC) Pipe, Fittings, Solvent Cement, and Risers

2.2.4.1 Pipe

Pipe shall conform to the requirements of ASTM D 1785, PVC 1120 Schedule 40 for all main lines and sleeved under concrete or asphalt over five feet in width; ASTM D 2241, PVC 1120 SDR 21, Class 200 & 315 for laterals.

2.2.4.2 Fittings

Solvent welded socket type fittings shall conform to requirements of ASTM D 2466, Schedule 40. Threaded type fittings shall conform to requirements of ASTM D 2464, Schedule 80.

2.2.4.3 Solvent Cement

Solvent cement shall conform to the requirements of ASTM D 2564.

2.2.4.4 Risers

Risers shall be schedule 80 PVC threaded at both ends and shall conform to ASTM D 2241.

2.2.5 Polyethylene (PE) Plastic Piping

2.2.5.1 Pipe

Pipe shall conform to AWWA C901, outside diameter base with dimension ratio (DR) of 9.3 to provide minimum pressure rating.

2.2.5.2 Fittings

Fittings shall conform to ASTM D 3261, DR of 9.3.

2.2.6 Dielectric Fittings

Fittings shall conform to ASTM F 441, Schedule 80, CPVC threaded pipe nipples, minimum length.

2.3 HEADS

2.3.1 Rotary Pop-Up Sprinklers

Sprinklers shall be gear driven with adjustable and full circle arc models. Sprinklers shall be capable providing various radius coverages at low

precipitation rates. Pop-up head design shall be pop up with adjustable radius capabilities. Construction shall be of high impact molded plastic with filter screen, drain check valve, and come with multiple nozzles. All heads shall be RAINBIRD 1800 series or equal.

2.3.2 Pop-Up Stream Bubblers

Pop-up stream bubblers shall be comform to the requirements of FS WW-H-001220, Type II, Class A B C D. Nozzle rises a minimum of 5 cm above the body. Full and part circle stream bubblers shall have matched precipitation rates and shall have a 0.125 cm NPT female threaded inlet. Heads to be of molded plastic and stainless steel construction. All heads shall be RAINBIRD 1800 series or equal.

2.4 VALVES

2.4.1 Gate Valves, Less than

Gate valves shall conform to the requirements of MSS SP-80, Type 1, Class 150, threaded ends.

2.4.2 Gate Valves,and Larger

Gate valves shall conform to the requirements of AWWA C509 and have encapsulated resilient wedge, parallel seats, non-rising stems, and open by counterclockwise turning. End connections shall be flanged. Interior construction of valves shall be bronze including stem containing a maximum 2 percent aluminum and maximum 16 percent zinc.

2.4.3 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.

2.4.4 Remote Control Valves, Electrical

Remote control valves shall be solenoid actuated globe valves of size, suitable for 24 volts, 60/50 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 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 valve from system.

2.4.5 Automatic Drain Valves

Automatic valves shall be brass or plastic, spring loaded ball drip type, and threaded ends, designed to close at pressure head with positive seal at pressure or greater and be open to drain at less than pressure.

2.4.6 Reduced Pressure Backflow Preventer Assembly

Reduced pressure backflow preventer assemblies shall be tested, approved, and listed in accordance with FCCHR-01. Reduced pressure backflow preventers shall be in accordance with ASSE 1013. Backflow preventers

shall be flanged bronze mounted gate valve and strainer, stainless steel or bronze internal parts. Total pressure drop through complete assembly shall be a maximum of at rated flow. Piping shall be galvanized steel pipe and fittings. Strainers shall be bronze or brass construction with gasket caps. Units shall have 200-mesh stainless steel screen elements.

2.5 ACCESSORIES AND APPURTENANCES

2.5.1 Valve Box

Valve boxes shall be plastic lockable. Box sizes shall be adjustable for valve sizes. Boxes shall be sized as required to provide for easy access. The following inscription shall be burnt or permanently marked into the appropriate boxes lid:

Type of Box	Inscription
Drip valve assembly box	"Valve"
Quick coupling valve box	"QC"
Gate valve box	"GV"
Automatic drain valve box	"DV"

2.5.2 Pressure Gauges

Pressure gauges shall conform to requirements of ASME B40.1, single style pressure gauge for water with dial brass or aluminum case, bronze tube, gauge cock, pressure snubber, and siphon. Scale range shall be suitable for irrigation sprinkler systems.

2.5.3 Service Clamps

Service clamps shall be bronze flat, double strap, with neoprene gasket or "O"-ring seal.

2.5.4 Water Hammer Arresters

Water hammer arrester shall conform to the requirements of ASME A112.26.1M; stainless steel construction with an encased and sealed bellows compression chamber.

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SECTION 02870

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SECTION 02870

SITE FURNISHINGS

PART 1 GENERAL

ALL SITE FURNISHINGS SHALL BE PROVIDED BY OTHERS

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.

FEDERAL SPECIFICATIONS

FF-H-116E	Hinges, Hardware, Builders

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 36/A 36m-87	Structural Steel

AMERICAN WELDING SOCIETY (AWS)

D1.1-86	Structural Welding Code-Steel

AMERICAN CONCRETE INSTITUTE (ACI)

318-8	Building Code Requirements for Reinforced Concrete (with Commentary)

PRESTRESSED CONCRETE INSTITUTE (PCI)

MNL-116	Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products
MNL-120-78	Design Handbook - Precast and Prestressed Concrete (2nd Ed., Errata)

1.2 INSPECTION OF CONDITIONS

Examine related work and surfaces before starting work of this section and report to the Contracting Officer in writing conditions which will prevent the proper provision of this work. Beginning the work of this section without reporting unsuitable conditions to the Contracting Officer constitutes acceptance of conditions. Any required removal, repair or replacement of this work caused by unsuitable conditions shall be done at no additional cost to the Government.

1.3 ACCEPTABLE MANUFACTURERS

Manufacturer named items are for standard of reference and do not necessarily limit supply to named manufacturers. Contracting Officer approved items of same physical size, function, and performance are

acceptable.

1.3.1 Footings

Site furniture tables, trash receptacle, and benches shall be capable of being located directly on concrete paving finish grade with no additional reinforcement necessary to the pavement section to accommodate additional loads.

1.4 DELIVERY AND HANDLING

Delivery shall be made to the job site and unloaded with a crane equipped-delivery truck as per manufacturer's recommendation. All site furnishings shall be unpacked and inspected for damage at time of delivery. Contractor shall also verify that model numbers, color, materials, etc. are as specified for the project. The Contracting Officer shall be notified of the visual confirmation.

1.5 GUARANTEE

Manufacturer shall guarantee, in writing, from defects in materials and workmanship all products supplied for a minimum period of one calendar year.

1.6 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer Information; GA .

Submit catalog cuts, product data and color samples for Government approval. Manufacturer's installation instructions and manufacturer's warranty for all items to be provided to the Contracting Officer. Manufacturer's footing specifications and calculations shall be provided.

SD-04 Drawings

Shop Drawings; FIO.

Submit shop drawings or manufacturer details for all the following products described herein including materials, design, layout, and assembly before installation.

PART 2 PRODUCTS

2.1 BENCHES

2.1.1 General

Construction shall be of solid metal rods welded to tubular steel frames. Arm-rests shall be of tubular steel welded to the seat frame at both ends of the bench length. Benches shall be designed to be embedded in imprinted textured color concrete.(see specification 02512 for concrete color and texture) Two bench types of one style shall be used. One type will be a

contoured seat with a back, which shall be placed on the curve of the outdoor paved contour. The second type shall be a contoured seat without a back which shall be placed on the curve within the outdoor room areas. (see details and plans)

2.1.2 Finish

The finish shall be powdercoat black color as per manufacturer's specifications. Utility surfaces shall be smooth. Type and color shall be approved by the by the Contracting Officer and match movable tables/chairs and trash receptacles.

2.2 TRASH RECEPTACLE

2.2.1 General

The receptacle shall be textured, three-dimensional "ribbed" exterior formed of linear medium density polyethylene which is resistant to UV rays, moisture, corrosive substances and extreme temperature changes. The receptacle shall have approximate dimensions of diameter by in height. The receptacles shall be supplied with a cable attached to the lid and container. A polyethylene liner shall be included.

2.2.2 Finish

The finish shall be integral black color. Finish materials shall be as per manufacturer's specifications. Type and color shall be approved by the Contracting Officer and match movable tables/chairs and benches.

2.3 MOVABLE TABLES & CHAIRS

2.3.1 General

Construction shall be of engineered metal material. Tables and chairs shall be of a contemporary movable style. The table shall have a rolled edge and curved/rounded base and shall be a minimum of 900mm diameter. The chairs shall have a contoured seat which offers comfort without a cushion. Chairs shall be stackable. Both shall be manufactured to withstand and constant exterior use.

2.3.2 Finish

The finish shall be powdercoat black color as per manufacturer's specifications. Utility surfaces shall be smooth. Type and color shall be approved by the by the Contracting Officer and match benches and trash receptacles.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

All site furnishings shall be located as shown on the drawings, and assembled and installed as per the manufacturer's specifications. The locations of all furnishings are to be marked in the field for the Contracting Officer's review and approval. The Contractor shall notify the

Contracting Officer 24 hours in advance of needed approval of location marking. Site furnishing installation schedule shall be coordinated with other contractors to avoid conflict and possible damage.

3.1.2 Benches

Benches shall be located, leveled, and installed on finished concrete grade as shown on plans. Exact field spacing shall be as per Contracting Officer's direction.

3.1.3 Trash Receptacles

Receptacles shall be located, leveled, and set on finished concrete grade as shown on plans. Exact field spacing shall be as per Contracting Officer's direction.

3.1.4 Movable Tables & Chairs

Tables shall be located within the outdoor room areas for both the faculty and students.

3.2 CLEAN-UP

3.2.1 General

General wiped clean with all tags and labels removed.

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SECTION 02935

TURF

PART 1 GENERAL

1.1 QUALIFICATIONS

All work shall be done by an experienced crew familiar with horticulture and industry methods and standards for sodding and turf installation.

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.

AGRICULTURAL MARKETING SERVICE (AMS)

AMS-01	(Sep 1977; Amended Oct 29, l986) Federal Seed Act Regulations (Part 20): Certified Seed Regulations

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 977	(1986) Emulsified Asphalt
ASTM D 2028	(1976; R 1986) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2607	(1969) Peats, Mosses, Humus, and Related Products

FEDERAL SPECIFICATIONS (FS)

FS O-F-241	(Rev D) Fertilizers, Mixed, Commercial
FS JJJ-S-181	(Rev B) Seeds, Agricultural

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Manufacturer's Literature; FIO.

Manufacturer's literature discussing physical characteristics, application

and installation instructions for erosion control material, and for chemical treatment material.

SD-07 Schedules.

Equipment List; FIO

A list of proposed pesticide application, seeding and mulching equipment to be used in performance of turfing operation, including descriptive data and calibration tests.

SD-08 Statements

Delivery; FIO.

Delivery schedule, at least 10 days prior to the intended date of the first delivery.

Application of Pesticide; FIO.

Pesticide treatment plan with proposed sequence of pesticide treatment work. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and method of application for all materials; and the name and state license number of the state certified applicator shall be included.

Maintenance Report; FIO.

Written record of maintenance work performed.

Turf Establishment Period; FIO.

Written calendar time period for the turf establishment period. When there is more than one turf establishment period, the boundaries of the turfed area covered for each period shall be described.

SD-13 Certificates

Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included (FIO):

a. Seed: (Not Applicable)

b. Sod: For species, mixture percentage, percent purity, field location.

c. Sprigs: (Not Applicable)

d. Fertilizer: For chemical analysis, composition percent.

e. Agricultural Limestone: (Not Applicable)

f. Peat: (Not Applicable)

g. Asphalt Adhesive: (Not Applicable)

h. Pesticide Material: For EPA registration number and registered uses.

i. Topsoil: For Ph, particle size, chemical analysis and mechanical analysis.

1.4 SOURCE INSPECTIONS

Sod material will be subject to inspection by the Contracting Officer at the growing site.

1.5 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Protection

Sod shall be protected from drying out and contamination during delivery.

1.5.1.2 Topsoil

A soil test shall be provided for topsoil delivered to the site.

1.5.1.3 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.

1.5.1.4 Pesticide

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.

1.5.2 Inspection

Sod shall be inspected upon arrival at the job site by the Contracting Officer for conformity to type and quality in accordance with paragraph MATERIALS. Other materials shall be inspected for meeting specified requirements and unacceptable materials shall be removed from the job site.

1.5.3 Storage

Materials shall be stored in areas designated by the Contracting Officer. Sod shall be installed immediately upon delivery. Temporary stored sod shall be lightly sprinkled with water, covered with moist burlap, straw, or other covering and protected from exposure to wind and direct sunlight until planted. Covering for sod shall allow air to circulate and prevent internal heat from building up. Fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment materials shall not be stored with other landscape materials.

1.5.4 Handling

1.5.4.1 Materials

Care shall be taken to avoid injury to sod or seed. Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.5.4.2 Time Limitation

a. Sod: Limitation of the time between harvesting and placing of sod shall be 36 hours.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Seed

State-approved seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentage of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws.

2.1.1.1 Seed Mixture

Seed mixtures shall be proportioned by weight as follows:

Botanical Name	Common Name	Mixture Percent by Weight	Percent Pure Live Seed
Tall Fescue	(hybird mix)	100%	98%

2.1.1.2 Quality

Seed shall conform to FS JJJ-S-181. Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected.

2.1.1.3 Seed mixing

The field mixing of seed shall be performed on site in the persence of the Contracting Officer.

2.1.2 Sod

2.1.2.1 Sod Classification

State-certified Nursery-grown sod shall be provided as classified by applicable state laws. Sod shall be regionally grown and adopted to project site conditions. Each individual sod section shall be of a size to permit rolling and lifting without breaking.

2.1.2.2 Grass Species

Grass species shall be proportioned for low maintenance and low water applications. The speies shall be a hybrid variety intermediate textured turf with good disease resistance. Species shall be cold hardy and have excellent wear and repair characteristics. Grass species shall be proportioned as follows:

Botanical Name	Common Name	Mixture Percent
Festuca elatior 'Alta'/	Tall Fescue	80%
Festuca elatior 'Goars'/	Tall Fescue	20%
Festuca elatior 'Kentucky 31'/	Tall Fescue	20%

2.1.2.3 Quality

The sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 50mm in any dimension, woody plant roots and other material detrimental to a healthy stand of turf. Sod that has become dry, moldy, or yellow from heating, or has irregularly shaped pieces of sod and torn or uneven ends shall be rejected.

2.1.2.4 Thickness

Sod shall be machine cut to a uniform thickness of 31mm within a tolerance of 6.3mm, excluding top growth and thatch. Measurement for thickness shall exclude top growth and thatch.

2.1.2.5 Anchors

Sod anchors shall be as recommended by the sod supplier.

2.1.3 Porous Grass Pavers

Porous grass pavers shall be constructed of a minimum of 97% post-consumer recycled materails, high density polyethylene. Pavers shall be UV stabilized. Pavers shall meet the specification RK Manufacturing, Inc. "Grassy Pavers" or equal.

2.1.4 Soil Amendments

Soil amendments shall consist of lime, fertilizer, organic soil amendments and manufactured soil conditioners meeting the following requirements.

2.1.4.1 Lime

Lime shall be agricultural limestone and shall have a minimum calcium carbonate equivalent of 90 percent and shall be ground to such a fineness that at least 90 percent will pass a 10-mesh sieve and at least 50 percent will pass a 60-mesh sieve.

2.1.4.2 Fertilizer

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to FS O-F-241. Granular Fertilizer: As recommended by the soil test, estimated to consist of nitrogen-phosphorus-potassium ratio: 16 percent nitrogen, 20 percent phosphorus, and 0 percent potassium.

2.1.4.3 Organic Soil Amendments

a. Topsoil: The existing surface soil shall be stripped and stockpiled on the site in accordance with Section 02210 GRADING. When required beyond that available from stripping, the topsoil shall be delivered. Delivered topsoil shall conform to topsoil requirements specified in Section 02210 GRADING, and shall be amended as recommended by soil test.

b. Peat: Peat moss or humus derived from a bog, swampland or marsh shall conform to ASTM D 2607.

c. Sand: Clean, free of toxic materials; 95 percent by weight shall pass a 10-mesh sieve and 10 percent by weight shall pass a 16-mesh sieve.

d. Rotted Manure: Well rotted, horse or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials, free of stones, sticks, soil and containing no chemicals or ingredients harmful to plants.

e. Decomposed Wood Derivatives: Ground bark, sawdust, or other wood waste material free of stones, sticks, soil, and toxic substances harmful to plants, stabilized with nitrogen and having the following properties:

Particle Size: Minimum percent by weight passing:

Screen Size	Percent
No. 4 mesh Screen	95
No. 8 mesh screen	80

Nitrogen Content: Minimum percent based on dry weight:

Material	Percent
Redwood Sawdust	0.5
Fir Sawdust	0.7
Fir or Pine Bark	1.0

f. Calcined Clay: (Not Applicable)

2.1.4.4 Soil Conditioner/Fertilizer

Soil conditioner and fertilizer shall be derived from organic materials such as decomposed animal, vegetable, and mineral matter, which has been composted, is relatively dry, friable, and pass a 25mm sieve. The conditioner shall not contain poultry, animal or human waste, pathogenic viruses, fly larvae, insecticides, fungicides, and poisonous chemicals that would inhibit plant growth. The conditioner shall be the following guaranteed chemical analysis:

Ingredient	Percentage (Minimum)
Nitrogen	5
Phosphoric Acid	3
Water Soluble Potash	1
Humus	50
Humic Acids	15
Soluble Metallic Iron	1

2.1.4.5 Gypsum

Gypsum shall be commercially packaged, free flowing, minimum 95 percent calcium sulfate by volume.

2.1.4.6 Porous Silica Aggregate

Porous silica aggregate shall be of commercial grade diatomaceous earth and be free flowing.

2.1.4.7 Iron Sulfate

Iron sulfate shall be commercially packaged, free flowing with an analysis of 19% Fe and 14% S.

2.1.6 Water

Water shall be from a designated reclaimed water source or a domestic water source.

2.1.7 Pesticide

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide and miticide. For the purpose of this specification, soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved insecticide, herbicide, fungicide, nematocide, rodenticide, miticide, and soil fumigant.

2.1.8 Erosion Control Material (Not Applicable)

PART 3 EXECUTION

3.1 PLANTING TIMES AND CONDITIONS

3.1.1 Seeding Time

Sod shall be placed from April to June for spring planting and from September to October for fall planting. Sod placement shall be timed to allow enough time for sod establishment before dormancy.

3.1.2 Sodding Time

Sod shall be placed from April to June for spring planting and from September to October for fall planting. Sod placement shall be timed to allow enough time for sod establishment before dormancy.

3.1.3 Porous Grass Pavers

Installations shall as per manufacturer's recommendation. Back fill with sandy Loam topsoil and seed with tall fescue seed mix.

3.1.4 Turfing Conditions

Turf 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 turf operations, proposed times shall be submitted to and approved by the Contracting Officer.

3.2 SITE PREPARATION

3.2.1 Grading

The Contracting Officer shall verify that finished grades are as indicated on drawings, and the placing of topsoil and the smooth grading has been completed in accordance with Section 02210 GRADING.

3.2.1.1 Soil Test

A soil test shall be performed for pH, chemical analysis and mechanical

analysis to establish the quantities and type of soil amendments required to meet local and site specific growing conditions for the type and variety of turf specified.

3.2.2 Application of Soil Amendments

The following soil amendments shall be incorporated into the soil if a manufactured soil conditioner/fertilizer is not utilized:

3.2.2.1 Soil Sulfur

Soil Sulfur shall be applied at the rate recommended by the soil test, estimated rate 32.8 pounds per 93 sq m. Sulfur shall be incorporated into the soil to a minimum depth of 150mm or may be incorporated as part of the tillage operation.

3.2.2.2 Fertilizer

Fertilizer shall be applied at the rate recommended by the soil test, estimated at 3 kg per 93 m2. Fertilizer shall be incorporated into the soil to a minimum depth of 150mm or may be incorporated as part of the tillage or hydroseeding operation.

3.2.2.3 Compost

A nitrogen stabilized compost shall be spread uniformly over the soil at the rate of 3 m3 per 93 m2 and thoroughly incorporated by tillage into the soil to a minimum depth of 150mm.

3.2.2.4 Porous Silica Aggregate

Porous silica aggregate shall be spread uniformly over the soil at the rate of 227 kg per 93 m2

3.2.2.5 Iron Sulfate

Iron sulfate shall be applied and incorporated uniformly into the soil at the rate of 2.3 kg per 93 m2.

3.2.3 Application of Soil Amendments Using Soil Conditioner/Fertilizer

The following soil amendment ratios shall be incorporated into the soil if a manufactured soil conditioner/fertilizer is used:

3.2.3.1 Soil Sulfur

Soil sulfur shall be applied at the rate recommended by the soil test, estimated rate 15 kg per 93 m2. Sulfur shall be incorporated into the soil to a minimum depth of 150mm or may be incorporated as part of the tillage operation.

3.2.3.2 Soil Conditioner/Fertilizer

Soil conditioner/fertilizer shall be applied evenly at the rate of 98 kg per 93 m2., and thoroughly incorporated as into the soil to a minimum depth of 150mm or may be incorporated as part of the tillage operation.

3.2.3.3 Porous Silica Aggregate

Porous silica aggregate shall be spread uniformly over the soil at the rate of 227 kg per 93 m2.

3.2.4 Tillage

3.2.4.1 Minimum Depth

Soil within turf areas shall be tilled minimum depth of 150mm. Rototiller shall be used where soil conditions and size of area permit.

3.2.5 Finished Grading

3.2.5.1 Preparation

Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of erosion or grade deficiencies shall conform to topsoil requirements specified in Section 02210 GRADING. Finished grade shall be 25mm below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas.

3.2.5.2 Turf Area Debris

Turf areas shall have debris and stones larger than 25mm in any dimension removed from the surface.

3.2.5.3 Protection

Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

3.3 SEEDING

3.3.1 General

Previously prepared seedbed areas compacted or damaged by interim rain, traffic, or other causes, shall be reworked to restore the ground condition previously speified. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.2 Equipment Calibration

The equipment to be used and the methods of turfing shall be subject to the inspection and approval of the Contracting Officer prior to commencement of turfing operations, the Contrator shall conduct turfing equipment alibration tests in the presence of the Contracting Officer.

3.3.3 Hydroseeding

Seed shall be uniformly spread at the rate of 3.5-4.0 kg per 4047 m2. Seed and fertilizer shall be added to water and thoroughly mixed at the rates speified. Wood cellulose fiber mulch shall be added at the rate of 545 kg per 4047 m2 after the seed, fertilizer, and water have been thouroughly mixed, to produce a homogeneous slurry. Slurry shall be uniformly applied under pressure over the entire area. The hydroseed shall not be rolled.

3.4 SODDING

3.4.1 General

Areas shall be sodded as indicated. Adequate soil moisture shall be ensured prior to sodding by spraying water on the area to be sodded and wetting the soil to a minimum depth of 25mm.

3.4.2 Placing Sod

Rows of sod shall be placed parallel to and tightly against each other. Joints shall be staggered laterally. The sod strips shall not be stretched or overlapped. All joints shall be butted tight. Voids and air drying of roots shall be prevented. On long slopes, sod shall be laid at right angles to slopes. In ditches, sod shall be laid at right angles to the flow of water. When required, the sod shall be anchored by placing anchors a minimum distance of 600mm on center with a minimum of 2 anchors per sod section.

3.4.3 Finishing

Air pockets shall be eliminated and a true and even surface shall be provided by tamping or rolling the sod in place. Displacement of the sod shall be assured by knitting of sod to the soil. Frayed edges shall be trimmed and holes or missing corners shall be patched in the sod.

3.4.4 Watering Sod

Watering shall be started immediately after completing each day of sodding. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of 25mm. Run-off and puddling shall be prevented.

3.5 SPRIGGING (Not Applicable)

3.6 EROSION CONTROL (Not Applicable)

3.7 APPLICATION OF PESTICIDE

When pesticide becomes necessary to remove a pest or disease, a state-certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of pesticides with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. A pesticide plan shall be provided to the Contracting Officer as stated in paragraph SUBMITTALS.

3.8 RESTORATION AND CLEAN UP

3.8.1 Restoration

Existing turf areas, pavements and facilities that have been damaged from the turfing operation shall be restored to original condition at Contractor's expense.

3.8.2 Clean Up

Excess and waste material shall be removed from the planting operation and shall be disposed of off the site. Adjacent paved areas shall be cleaned.

3.9 PROTECTION OF TURFED AREAS

Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed by the Contracting Officer.

3.10 TURF ESTABLISHMENT PERIOD

3.10.1 Commencement

The Turf Establishment Period for establishing a healthy stand of turf shall begin on the first day of work under this contract and shall end 60 days after the last day of turfing operations required by this contract. Written calendar time period shall be furnished to the Contracting Officer for the Turf Establishment Period. When there is more than one turf establishment period, describe the boundaries of the turfed area covered for each period.

3.10.2 Satisfactory Stand of Turf

3.10.2.1 Sodded Area

A satisfactory stand of turf from the sodding operation is defined as vigorous living sod uniform in rooting and top growth.

3.10.3 Maintenance During Establishment Period

3.10.3.1 General

Maintenance of the turfed areas shall include eradicating weeds, eradicating insects and diseases, protecting embankments and ditches from erosion, maintaining erosion control materials and mulch, protecting turfed areas from traffic, mowing, watering, and post-fertilization.

3.10.3.2 Mowing

a. Lawn Areas: Lawn areas shall be mowed to a minimum height as recommended by the seed producer when the average height of the turf becomes 50mm. Clippings shall be removed when the amount of cut turf is heavy enough to damage the turfed areas.

b. Field Areas: Field areas shall be mowed once during the season to a minimum height of 75mm.

3.10.3.3 Watering

Watering shall be at intervals to obtain a moist soil condition to a minimum depth of 25mm. Frequency of watering and quantity of water shall be adjusted in accordance with the growth of the turf. Run-off, puddling and wilting shall be prevented.

3.10.3.4 Post-Fertilization

Nitrogen carrier fertilizer shall be applied at the rate of 3 kg per 93 m2 after the first month and again every three months to the final acceptance. The application shall be timed prior to the advent of winter dormancy and shall avoid excessively high nitrogen levels.

3.10.3.5 Pesticide

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.10.3.6 Repair

The Contractor shall re-establish as specified herein, eroded, damaged or barren areas. Mulch shall also be repaired or replaced as required.

3.10.3.7 Maintenance Report

A written record shall be furnished to the Contracting Officer of the maintenance work performed.

3.11 FINAL ACCEPTANCE

3.11.1 Preliminary Inspection

Prior to the completion of the Turf Establishment Period, a preliminary inspection shall be held by the Contracting Officer. Time for the inspection shall be established in writing. The acceptability of the turf in accordance with the Turf Establishment Period shall be determined. A unacceptable stand of turf shall be repaired as soon as turfing conditions permit.

3.11.2 Final Inspection

A final inspection shall be held by the Contracting Officer to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection shall be established in writing.

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SECTION 02950

PLANTING AND LANDSCAPING

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 Z60.1	(1986) American Standard for Nursery Stock

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2607	(1969) Peats, Mosses, Humus, and Related Products

FEDERAL SPECIFICATIONS (FS)

FS 0-F-241	(Rev D) Fertilizers, Mixed, Commercial

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL DESCRIPTIONS:

SD-07 Schedules

Delivery Schedule; FIO

Delivery Schedule, before work is started, at least 10 days prior to the intended date of the first delivery.

SD-09 Reports

Soil Test; FIO.

Percolation Test; FIO.

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-13 Certificates

Soil Amendments;FIO.

Plants;FIO.

Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Reports for the following materials shall be included.

a. Topsoil: Not Applicable.

b. Fertilizer: For chemical analysis and composition percent.

c. Agricultural Limestone: (Not Applicable)

d. Peat: (Not Applicable)

e. Plant Materials: For botanical and common name, size, quantity by species, grade, nursery grown.

f. Pesticide Material: For EPA registration number and registered uses.

SD-18 Records

Maintenance Period;FIO.

Written calendar time period for the beginning of 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.

Maintenance Report;FIO.

Written record of maintenance work performed and quantity of plant losses and replacements.

Maintenance Instructions;FIO.

Written instructions for year-round care and upkeep of installed plants, landscaping, and irrigation system.

1.3 SOURCE INSPECTIONS

1.3.1 Plant Materials

Plant materials shall be subject to inspection at the growing site by the Contracting Officer.

1.4 SHIPMENT, DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Shipment

1.4.1.1 Preparation

Preparation for shipment shall be done in a manner that will not cause shock or damage to branches, trunk, or root systems. Container grown plant sizes shall be provided as recommended by ANSI Z60.1. Plants shall be grown in a container sufficiently long for new fibrous roots to have developed and for root mass to retain its shape and hold together when removed from container. Container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

1.4.1.2 Antidesiccant Application

Plants shall be sprayed with an antidesiccant as leaf budding occurs or when plant material has soft growth.

1.4.2 Delivery

1.4.2.1 Identification

Plants shall be identified with durable waterproof labels and weather-resistant ink. Plants shall have attached labels stating the correct plant name and size.

1.4.2.2 Protection During Delivery

Plants shall be protected during delivery to prevent desiccation of the plant or damage to the roots or balls. Branches of plants shall be protected by tying-in the branches and covering all exposed branches.

1.4.2.3 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.

1.4.2.4 Pesticide

Pesticide materials shall be delivered to the site in the original unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration numbers and the registered uses.

1.4.3 Inspection

Plant material shall be inspected upon arrival at the job site by the Contracting Officer for conformity to the paragraph PLANTS and paragraph Shipment, and any unacceptable plant material shall be removed from the job site.

1.4.4 Storage

1.4.4.1 Plant Storage

Plants not installed on the day of arrival at the site shall be stored and protected in areas designated by the Contracting Officer. Plants shall be protected from exposure to wind and shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. All plants shall be kept in a moist condition by watering with a fine mist spray until planted.

1.4.4.2 Storage of Other Materials

Soil amendments shall be stored in dry locations away from contaminants. Pesticide materials shall not be stored with other landscape materials. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

1.4.5 Handling

Care shall be taken to avoid injury to plants. Materials shall not be

dropped from vehicles. Container-grown plants shall be handled by the container. Plants shall not be handled by the trunk or stems.

1.4.5.1 Time Limitation

Mulch: Limitation of time between installing plant and placing mulch is 48 hours.

1.5 WARRANTY

Furnished plants shall be guaranteed to be in a vigorous growing condition for a period of 12 months regardless of the contract time period. A plant shall be replaced one time under this guarantee. A written calendar time period for the guarantee of plant growth shall be furnished to the Contracting Officer.

PART 2 PRODUCTS

2.1 PLANTS

2.1.1 Varieties

Plants shall be nursery grown or plantation grown stock conforming to ANSI Z60.1 and shall be of the varieties specified in the plant list bearing botanical names listed in one or more of the publications listed under "Nomenclature" in ANSI Z60.1.

2.1.2 Substitutions

Substitutions will not be permitted without written request from the Contractor for approval by the Contracting Officer.

2.1.3 Growing Conditions

All plants shall be grown under climatic conditions similar to those in the locality of the project or acclimatized for a period of 6 months prior to installation.

2.1.4 Quality

Well shaped, well grown, vigorous, healthy plants having healthy and well branched root systems shall be provided. Plants shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plants shall be provided that are typical of the species or variety and conforming to standards as set forth in ANSI Z60.1 and as specified herein.

2.1.4.1 Shade and Flowering Trees

A height relationship to caliper shall be provided as recommended by ANSI Z60.1. Height of branching should bear a relationship to the size and variety of tree specified and with the crown in good balance with the trunk. Trees shall not be "poled" or the leader removed.

a. Single stem: Trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Specimen: A plant shall be provided that is 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.

2.1.4.2 Deciduous Shrub

Plants shall be provided that have the height and number of primary stems as recommended by ANSI Z60.1. An acceptable plant shall be well shaped with sufficient well-spaced side branches recognized by the trade as typical for the variety grown in the region.

2.1.4.3 Coniferous Evergreen

Trees shall be provided that have the height-to-spread ratio as recommended by ANSI Z60.1. Trees shall not be "poled" or the leader removed. An acceptable plant 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.

2.1.4.4 Broadleaf Evergreen

Plants shall be provided that have ratio of height-to-spread as recommended by ANSI Z60.1. An acceptable plant shall be well shaped and recognized by the trade as typical for the variety grown in the region.

2.1.5 Size

Plants shall be furnished in sizes indicated. Plants larger in size than specified may be provided at no additional cost to the Government.

2.1.6 Measurement

Plant measurements shall be in accordance with ANSI Z60.1.

2.2 TOPSOIL

Topsoil shall be the existing surface soil stripped to the depth indicated and stockpiled on the site in accordance with Section 02210 GRADING. Additional topsoil, if required, beyond that available from stripping operations, shall be delivered. Delivered topsoil shall conform to topsoil requirement specified in Section 02210 GRADING and shall be amended as recommened by soil tests for the plants specified.

2.2.1 Soil Test

A soil test shall be performed for Ph, particle size, chemical analysis and mechanical analysis to establish the quantities and type of soil amendments required to meet local growing conditions for the type and variety of plants specified.

2.3 SOIL AMENDMENTS

Soil amendments consist of lime, fertilizer, bonemeal, organic soil amendments and soil conditioner.

2.3.1 Lime

Lime shall be agricultural limestone and shall have a minimum calcium carbonate equivalent of 90 percent and shall be ground to such a fineness that at least 90 percent will pass a 10-mesh sieve and at least 50 percent

will pass a 60-mesh sieve.

2.3.2 Dry Fertilizer

Dry fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to FS 0-F-241. Fertilizer shall be controlled-release fertilizer consisting of nitrogen-phosphorous-potassium ratio: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium. Controlled-release fertilizer shall be in tablet form.

2.3.3 Bonemeal

Bonemeal shall be a finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.3.4 Organic Soil Amendments

2.3.4.1 Peat

Peat shall be a natural product of peat humus derived from a bog, swampland or marsh and shall conform to ASTM D 2607

2.3.4.2 Sand

Sand shall be clean and free of toxic materials and at least 95 percent by weight shall pass a 10-mesh sieve, and 10 percent by weight shall pass a 16-mesh sieve.

2.3.4.3 Rotted Manure

Rotted manure shall be unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials and containing 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.

2.3.4.4 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants and stabilized with nitrogen and having the following properties:

Particle size	Minimum percent by weight passing
No. 4 mesh screen	95
No. 8 mesh screen	80

Nitrogen Content	Minimum percent based on dry weight
Redwood Sawdust	0.5
Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.5 Soil Conditioner

For single use or in combination to meet requirements for planting backfill.

2.3.5.1 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum of 95 percent calcium sulfate by volume.

2.3.5.2 Aluminum Sulfate

Aluminum sulfate shall be commercial grade.

2.4 MULCH

Mulch shall be of an inert mulch material and free from weeds, debris, and other deleterious materials.

2.4.1 Shredded Bark

Commercially available shredded bark and wood product made of redwood, cedar, or fir material. Bark shall be free from dirt and non-organic materials. Submit sample to Contracting Officer.

2.5 STAKING MATERIAL

2.5.1 Bracing Stakes

Bracing stakes for tree support shall be pentachlorophenol treated lodge pole pine free of any defects that would impair the strength. Bracing stakes shall be minimum diameter by 8' long and pointed at one end.

2.5.2 Tree Ties

Material for holding tree to stake shall be a commercially available rubber tie.

2.6 WATER

Water shall not contain elements toxic to plant life. Water will be furnished from the project mainline or a Government fire hydrant on the base.

2.7 ANTIDESICCANT

Antidesiccant shall be an emulsion that will provide a film over plant surfaces permeable enough to permit transpiration, and shall not damage the plant.

2.8 HERBICIDE

Pre-emergent herbicide shall be in a commercially available dry or liquid form that is easily applied and meet all local and state regulations.

2.9 PLANTERS

All raised planters shall be constructed to heights stated on the landscape plans. All raised planters shall be constructed to split face/smooth face CMU block. (see landscape details)

2.10 BERMS AND MOUNDS

Landscape berms shall be formed from clean native soil that is free from foreign or construction debris. Coordinate with CMU wall construction and rough grading. Compact and settle by construction equipment walking. Rough

grade shall be ripped to to break up construction compaction before placement of berm material.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Verify Grades

The Contracting Officer shall verify the finished grades are as indicated on drawings, and smooth grading has been completed in accordance with Section 02210 GRADING before start of landscape berm placement and other landscape operations.

3.1.2 Underground Obstructions to Planting

The location of underground utilities and facilities shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.2 SITE PREPARATION

3.2.1 Layout

Landscape berms, CMU walls, plant material locations, and mulch outlines shall be staked on the project site before any excavation is made. Plant material, berms, mulch, and boulder locations may be adjusted by the Contracting Officer to meet field conditions.

3.3 EXCAVATION

3.3.1 Obstructions Below Ground or Poor Drainage

When obstructions below ground or poor drainage affect the contract operation, proposed adjustments to landscape element locations, type of plant and planting method or drainage correction shall be submitted to and approved by the Contracting Officer.

3.3.2 Plant Pits

Plant pits shall be dug to produce vertical sides and flat, uncompacted bottoms. When pits are dug with an auger and the sides of the pits become glazed, the glazed surface shall be scarified. The size of all plant pits, except for palms, shall be 2 times rootball width and a minimum depth which will set plant crowns level with the top of water basin rim. See Tree and Shrub Planting Details.

3.3.3 Raised Planters

All raised planter shall be cleared of all debris and concrete material to natural rough grade. Interior grade shall be tilled to break up construction compaction and create a open interface with backfill material. A drainage test shall be performed for each planter and the Contrating Officer shall be notified of any drainage concerns. Backfill planter mix shall be placed to the specified depth allowing for settling coordinated during backfilling. Coordinate work with irrigation and electrical.

3.3.4 Rough Grading and Landscape Berms

All grades and landscape berms shall follow the designed slope and swales for drainage.

3.3.4.1

All rough grades shall drain away from buildings and be below finish grade of walks, curbs, etc. to allow for mulch placement.

3.3.4.2

Landscape berms shall be laid out and constructed as shown on plans and as adjusted to meet field conditions. Coordinate with CMU wall construction and rough grading. Berms shall be constructed in lifts and compacted by construction equipment walking. Final shaping shall be to provide natural contours and transitions to adjacent areas with positive drainage to swales and streets.

3.4 PERCOLATION TEST

Test for percolation shall be done to determine positive drainage of plant pits and beds. The Contracting Officer shall be notified in writing of all soil and drainage conditions detrimental to growth of plant material and shall submit proposal for correcting the condition.

3.5 PLANTING TIMES AND CONDITIONS

For best results, install container grown plant material in the fall before the chance of the first frost or in the spring after the last chance of frost. Planting 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. Contractor shall schedule planting in the mornings to avoid stressing plants during installation, if the planting schedule calls for installation when the temperature is expected to be 90 degrees Fahrenheit or greater. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted to and approved by the Contracting Officer.

3.6 INSTALLATION

3.6.1 Backfill Mixtures

Backfill shall be installed as part of the installation operations. The backfill mixture shall be a proportioned mixture thoroughly mixed by volume of clean native soil and selected organic soil amendment(s) of a decomposed wood derivative nature.

3.6.1.1 Backfill Soil Mix

The basin backfill soil mixture shall be placed in the planting pits during plant installation operations. The basin backfill soil mixture shall be as follows:

Clean Native Soil	=	1	part to mixture
Organic Soil Amendment(s)	=	2	parts to mixture

3.6.2 Setting Plants

Plants shall be set plumb and held in position until sufficient backfill

soil mix has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they were grown in the nursery, or container. Plants root crown shall be set above subgrade as specified on drawings.

3.6.3 Rain Basins

A depressed rain basin shall be formed around individual plants. Basin shall be excavated from around planting, and shall be level and continuous around plant.

3.6.4 Dry Fertilizer

Dry fertilizer shall be placed in tablet form in the plant pit in the immediate vicinity of the feeding roots in accordance with the manufacturer's recommendations. Space tablets at equal distances from each other and the rootball. The tablets shall be allotted as follows:

15 gallon container plants	= 4 tablets (21 grams each or equivalent)
5 gallon container plants	= 3 tablets (21 grams each or equivalent)
1 gallon container plants	= 1 tablets (21 grams each or equivalent)

3.6.5 Container-Grown Plants

Non-biodegradable containers shall be removed without damage to the plant or root system. Biodegradable containers shall be split. The backfill mix shall be completed, tamped and watered.

3.6.6 Staking

All trees shall be held in place with two bracing stakes driven vertically into ground and placed on opposite sides. Stakes shall not injure the ball or roots. The tree shall be held firmly between the stakes with a double strand of wire. Chafing guards shall be used where the wire contacts the tree. Nursery stakes shall be untied and removed from stem, if applicable. Care shall be taken so that the stem is supported during this operation and is not allowed to bend to the point of damage before the tree stakes are in place and the tree is secured.

3.7 FINISHING

3.7.1 Pruning

The total amount of foliage shall be pruned by one-fourth to one-third on installed trees and shrubs to compensate for loss of roots and transplanting shock. The typical growth habit of individual plants 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 shall not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off." Cuts or wounds measuring a minimum in diameter shall be painted with the specified tree wound dressing.

3.7.2 Pre-emergent Herbicide

Pre-emergent herbicide shall be applied as per manufacturer's specifications on all landscape areas after finish grading and prior to rock mulch installation.

3.7.3 Mulch

After irrigation installation and rough grading, mulch bed outlines shall be marked on the ground as per drawings and field conditions for approval by the Contracting Officer prior to installation of any mulch or plantings. Pre-emergent herbicide shall be applied before placement of any mulch.

3.7.4 Water

Plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone. Run-off, puddling and wilting shall be prevented.

3.7.5 Antidesiccant Application

Plants requiring further protection shall be sprayed with anti-desiccant in accordance with manufacturer's recommendations.

3.8 MAINTENANCE DURING PLANTING OPERATION

Installed plants shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed and shall continue until the plant establishment period commences. The maintenance includes irrigation system upkeep, watering, pruning, wound dressing, straightening and other necessary operations. Plant beds and earth water basins shall be kept free of weeds, grass and other undesired vegetation. Plants shall be checked for settlement and shall be reset proper grade as necessary. Run-off, puddling and wilting shall be prevented.

3.9 APPLICATION OF PESTICIDE MATERIAL

When pesticide becomes necessary to remove a disease or pest, a state-certified applicator shall apply required pesticide in accordance with State EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of pesticides with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. A pesticide treatment plan shall be provided to the Contracting Officer as specified in paragraph SUBMITTALS.

3.10 RESTORATION AND CLEAN UP

3.10.1 Restoration

Pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

3.10.2 Clean Up

Excess and waste material from the planting operation shall be removed and disposed of off the site. Adjacent paved areas shall be cleared.

3.11 MAINTENANCE PERIOD

3.11.1 Commencement

On completion of the last day of the planting and landscaping operation and all other construction activity including architectural, civil, etc., the maintenance period for maintaining irrigation, hardscape, and installed

plants in a healthy growing condition shall commence upon written notice of 'start of maintenance period' from the Contracting Officer. The maintenance period shall be in effect for 365 calendar days.

3.11.2 Maintenance During Establishment Period

3.11.2.1 General

Maintenance of plants and landscape shall include straightening plants, tightening stakes and guying material, repairing tree wrapping, protecting plant areas from erosion, maintaining erosion control material, supplementing mulch, accomplishing wound dressing, removing dead or broken tip growth by pruning, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, watering, weeding, removing and replacing unhealthy plants, and adjusting and maintaining irrigation system as required.

3.11.2.2 Water

The plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone and encourage deep rooting. An adequate supply of moisture is estimated to be the equivalent of of absorbed water per week delivered in the form of natural rain or augmented as required by periodic watering. Run-off, puddling and wilting shall be prevented.

3.11.2.3 Weeding

Grass and weeds in earth water basins and landscape areas shall not be allowed to reach a height of 25mm+ before being completely removed, including the root growth.

3.11.2.4 Unhealthy Plants

A plant shall be considered unhealthy or dead when the main leader has died back, or 25 percent of the crown is dead. Determine the cause for an unhealthy plant. Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

3.11.2.5 Settlement

Native soil or mulch material shall be added to maintain grade and coverage. Serious settlement affecting the setting of the plant in relation to the depth at which it was grown requires replanting in accordance with paragraph INSTALLATION.

3.11.2.6 Pesticide Treatment

Treatment for diseases or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE MATERIAL.

3.11.2.7 Maintenance Report

A written record shall be furnished to the Contracting Officer of the maintenance work performed, irrigation adjustments and repairs, the quality of plant losses, cause for plant loss and replacements made on each site visit.

3.11.2.8 Maintenance Instruction

Written instructions shall be furnished to the Contracting Officer for year-round care of installed plants and irrigation system.

3.11.3 Replacement Plants

Plants shall be provided for replacement in accordance with paragraph PLANTS. Replacement plants shall be installed in accordance with paragraph INSTALLATION. No extended plant establishment period shall be required for replacement plants. A plant will be replaced in accordance with paragraph WARRANTY.

3.12 FINAL ACCEPTANCE

3.12.1 Preliminary Inspection

Prior to the end of the maintenance period, a preliminary inspection shall be held by the Contracting Officer. Time for the inspection shall be established in writing. A checklist of items to be done will be determined, such as irrigation adjustments, plants to be replaced, mulch replacement, etc. These items will be checked for completion at the Final Inspection.

3.12.2 Final Inspection

At the end of the maintenance period, a final inspection shall be held by the Contracting Officer to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection shall be established in writing. Acceptance of the planting is subject to the guarantee of plant vigor and growth.

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SECTION 03100

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SECTION 03100

STRUCTURAL CONCRETE FORMWORK

PART 1 GENERAL

1.1 REFERENCES

The following referenced documents, standard practices and test methods represent the standard and care expected in the execution of Contractor quality control and quality assurance. The publications listed below form a part of this specification, but include only some of the most important or frequently used test methods. All cross referenced methods and standards also form a part of this specification to the extent needed to accomplish quality control and quality assurance. Standards and publications are often referred to in the text by their basic designation. If there is a conflict in test methods, the Government will determine which test or method governs.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 347R (1988) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1982; R 1988) Basic Hardboard

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1983) Construction and Industrial Plywood

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Design; GA.

Design analysis and calculations for form design and methodology used in the design.

Concrete Formwork; FIO.

Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

SD-04 Drawings

Concrete Formwork; FIO.

Drawings showing details of formwork including, joints, supports, studding and shoring, and sequence of form and shoring removal.

SD-06 Instructions

Form Releasing Agents; FIO.

Manufacturer's recommendation on method and rate of application of form releasing agents.

1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

PART 2 PRODUCTS

2.1 FORM MATERIALS

2.1.1 Forms For Class B Finish

Forms for Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

2.1.3 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.4 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05300 STEEL DECKING.

2.1.5 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that

will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 6 mm nor more than 25 mm deep and not more than 25 mm in diameter. Removable tie rods shall be not more than 38 mm in diameter.

2.1.6 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents 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.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 REMOVAL OF FORMS

Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete

may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

3.5 CONSTRUCTION QUALITY CONTROL

Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

The following referenced documents, standard practices and test methods represent the standard and care expected in the execution of Contractor quality control and quality assurance. The publications listed below form a part of this specification, but include only some of the most important or frequently used test methods. All cross referenced methods and standards also form a part of this specification to the extent needed to accomplish quality control and quality assurance. Standards and publications are often referred to in the text by their basic designation. If there is a conflict in test methods, the Government will determine which test or method governs.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(1989; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1994) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184	(1990) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 615	(1994) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 706	(1993a) Low-Alloy Steel Deformed Bars for Concrete Reinforcement

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1992) Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1	(1990) Manual of Standard Practice

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Concrete Reinforcement System; GA

Detail drawings showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-08 Statements

Qualifications; FIO

A list of names of qualified welders.

SD-13 Certificates

Reinforcing Steel; FIO

Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.3 QUALIFICATIONS

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184.

2.2 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615 or ASTM A 706, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82.

2.3 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.4 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 100 by 100 mm (4 by 4 inches) 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 13 mm 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 ofACI 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 or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. 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 one-fifth the required length of lap or 150 mm. 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 CONSTRUCTION QUALITY CONTROL

Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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SECTION 03250

EXPANSION JOINTS AND CONTRACTION JOINTS

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	(1982; R 1988) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

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 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 5249	(1992) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

FEDERAL SPECIFICATIONS (FS)

FS SS-S-1401	(Rev C; Notice 1) Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements
FS SS-S-200	(Rev E; Am 2) Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Materials; FIO.

Manufacturer's catalog data and manufacturer's recommended instructions for

joint fillers and sealants.

SD-13 Certificates

Materials; GA.

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 3 mm (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 10 mm (3/8 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 Hot-Poured Type

FS SS-S-1401,
FS SS-S-200

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 3 mm wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 25 mm.

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. Means shall be provided to insure true alignment of the strips is 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. 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 3 mm (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 thereof 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. Joints sealed with field molded sealant shall be completely filled with sealant.

3.2 CONSTRUCTION QUALITY CONTROL

Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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SECTION 03300

CONCRETE FOR BUILDING CONSTRUCTION

PART 1 GENERAL

1.1 REFERENCES

The following referenced documents, standard practices and test methods represent the standard and care expected in the execution of Contractor quality control and quality assurance. The publications listed below form a part of this specification, but include only some of the most important or frequently used test methods. All cross referenced methods and standards also form a part of this specification to the extent needed to accomplish quality control and quality assurance. Standards and publications are often referred to in the text by their basic designation. If there is a conflict in test methods, the Government will determine which test or method governs.

AMERICAN CONCRETE INSTITUTE (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 301	(1989) Structural Concrete for Buildings
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1989; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1992a) Concrete Aggregates
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1990) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 94	(1994) Ready-Mixed Concrete
ASTM C 109	(1993) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete

ASTM C 150	(1994) Portland Cement
ASTM C 171	(1992) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 173	(1994a) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192	(1990a) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1994) Air-Entraining Admixtures for Concrete
ASTM C 309	(1993) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595	(1994a) Blended Hydraulic Cements
ASTM C 597	(1983; R 1991) Pulse Velocity Through Concrete
ASTM C 618	(1994) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 803	(1990) Penetration Resistance of Hardened Concrete
ASTM C 805	(1985) Rebound Number of Hardened Concrete
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM E 96	(1994) Water Vapor Transmission of Materials

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467	(Rev C) Cloth, Burlap, Jute (or Kenaf)

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA-01	(1992) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau
NRMCA CPMB 100	(1990) Concrete Plant Standards
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready-Mixed Concrete Production Facilities

U.S. ARMY CORPS OF ENGINEERS HANDBOOK FOR CEMENT AND CONCRETE (CRD)

COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 621	(1988) Specification for Non-Shrink Grout

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-08 Statements

Mixture Proportions; GA

The results of trial mix along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 30 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 independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Sampling and Testing; FIO

Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD-13 Certificates

Cementitious Materials; FIO

Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan. No cement and pozzolan shall be used until notice of acceptance has been given. Cement and pozzolan may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

1.3 GENERAL REQUIREMENTS

Tolerances for concrete construction and materials shall be in accordance with ACI 117/117R.

1.3.1 Strength Requirements

Structural concrete for lightly loaded slabs-on-grade and footings shall

have minimum 28-day compressive strength of 21 MPa (3000 psi). Structural concrete for equipment pads, concrete fire lane and heavily loaded slabs-on-grade shall have minimum 28-day compressive strength of 28 MPa (4000 psi). Concrete for thrust blocks shall have a 28-day compressive strength of 14 MPa (2000 psi). Compressive strength shall be determined in accordance with ASTM C 39.

1.3.2 Air Entrainment

All normal weight concrete shall be air entrained to contain between 3 and 5 percent total air. Air content for normal weight concrete shall be determined in accordance with ASTM C 231.

1.3.3 Special Properties

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved.

1.3.4 Slump

Slump shall be within the following limits:

Structural Element	Slump in millimeters Minimum	Maximum
Walls, columns and beams	50	100
Foundation walls, substructure walls, footings, pavement, and slabs	25	75
Any structural concrete approved for placement by pumping:		
At pump	50	150
At discharge of line	25	100

*Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

1.4 PROPORTIONS OF MIX

1.4.1 Mixture Proportioning, Normal Weight Concrete

Trial batches shall contain materials proposed to be used in the project. 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 mix design. Trial mixes shall be proportioned to produce concrete strengths specified. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders or beams for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength. For each strength of concrete the maximum allowable water-cement ratio shall be that shown by these curves to produce an average strength as specified in paragraph AVERAGE STRENGTH. If pozzolan is utilized, it shall be proportioned by 20 to 25 percent by volume of cement replacement.

1.4.2 Average Strength

In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. 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 within 7 MPa 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 or at other test age designated for determination of the specified strength.

1.4.2.1 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 500.

1.4.2.2 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

No. of tests (1)	Modification factor for standard deviation
less than 15	See Note
15	1.16
20	1.08
25	1.03
30 or more	1.00

(1) Interpolate for intermediate numbers of tests.

When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be:

a. The specified strength plus 7 specified strength of less than 21 MPa.

b. The specified strength plus 8 for specified strengths of 21 to 35 MPa.

c. The specified strength plus 10 for specified strengths greater than 35 MPa.

1.5 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. 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. 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.

PART 2 PRODUCTS

2.1 ADMIXTURES

Admixtures shall conform to the following:

2.1.1 Accelerating Admixture

ASTM C 494, Type C or E.

2.1.2 Air-Entraining Admixture

ASTM C 260.

2.1.3 Flowing Concrete Admixture

ASTM C 1017, Type 1 or 2.

2.1.4 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, D, F, or G. Type G admixture shall not be used for slabs-on-grade.

2.2 CEMENTITIOUS MATERIALS

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.2.1 Cement

ASTM C 150, Type II, low alkali.

2.2.2 Portland-Pozzolan Cement

ASTM C 595, Type IP, low alkali.

2.2.3 Pozzolan

ASTM C 618, Class F. Loss on ignition shall not exceed 3.0 percent. Supplementary optional chemical requirements shall apply.

2.3 AGGREGATES

Aggregates shall conform to the following:

2.3.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

2.3.2 Coarse Aggregate

The coarse aggregate shall consist of two blended fractions meeting the gradation requirement of ASTM C 33, size 467 (37.5 to 4.75 mm).

2.4 CURING MATERIALS

2.4.1 Burlap

FS CCC-C-467.

2.4.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.4.3 Membrane-Forming Compounds

ASTM C 309, Type 1-D, Class A or B.

2.5 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to COE CRD-C 621 and shall be a formulation suitable for the application.

2.7 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.

2.8 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 0.5 mm (20 mils) or other equivalent material having a vapor permeance rating not exceeding 28.6 nanograms per Pascal per second per square meter (0.5 perms) as determined in accordance with ASTM E 96. Sheeting shall be covered by a 100 mm thick layer of sand, which conforms to ASTM C 33. Sand shall be moistened and compacted by two passes of a 550 kg (minimum) vibratory plate compactor.

2.9 WATER

Water shall be potable, except that nonpotable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for

curing shall not contain any substance injurious to concrete, or which causes staining.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

3.1.1 Foundations

Earthwork shall be as specified in Section 02221 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but without free water when concrete is placed. Semiporous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 150 mm of the in-place pervious material or by covering with an impervious membrane.

3.1.2 Vapor Barrier

Unless otherwise indicated, subgrades for slabs in buildings shall be covered with a vapor barrier. Vapor barrier edges shall be lapped at least 100 mm and ends shall be lapped not less than 150 mm. Patches and lapped joints shall be sealed with pressure-sensitive adhesive or tape not less than 50 mm wide and compatible with the membrane.

3.1.3 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.2 INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3.3 BATCHING, MIXING AND TRANSPORTING CONCRETE

Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating units shall comply with NRMCA-01. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Site-mixed concrete shall be mixed in accordance with ACI 301. On site plant shall conform to the NRMCA CPMB 100.

3.3.1 Admixtures

Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

3.3.2 Control of Mixing Water

No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch except when on arrival at the jobsite, the slump of the concrete is less than that specified. Water added to bring the slump within the specified range shall not change the total water in the concrete to a point that the approved water-cement ratio is exceeded. The drum shall be turned an additional 30 revolutions, or more, if necessary, until the added water is uniformly mixed into the concrete. Water shall not be added to the batch at any later time.

3.4 SAMPLING AND TESTING

Sampling and Testing is the responsibility of the Contractor and shall be performed by an approved testing agency. All sampling, testing, recording and submittal of test results shall be in accordance with the Construction Control Manual.

3.4.1 Aggregates

Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33. Gradation tests shall be performed on the first day and every other day thereafter during concrete construction.

3.4.2 Sampling of Concrete

Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172

3.4.2.1 Air Content

Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231.

3.4.2.2 Slump

At least 2 slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete placement. Tests shall be performed in accordance with ASTM C 143.

3.4.3 Evaluation and Acceptance of Concrete

3.4.3.1 Frequency of Testing

Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day. Number and frequency of test speciments shall be in accordance with the Construction Control Manual. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of

curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.4.3.2 Testing Procedures

Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders or beams made from the same sample of concrete and tested at 28 days or at another specified test age.

3.4.3.3 Evaluation of Results

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 required strength by more than 3.4 MPa. If any of these requirements are not met, the Contracting Officer will require changes in the proportions of the concrete mix.

3.4.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 3.4 MPa, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. 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 shall be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 16 to 27 degrees C, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. 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 and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

3.5 CONVEYING CONCRETE

Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph CONCRETE PLACEMENT by methods which will prevent segregation or loss of ingredients. Each load of concrete shall be visually inspected for slump conformance prior to entering the conveyance apparatus or forms. Inspections shall be made by a person who has been certified by the American Concrete Institute to perform such inspection. Concrete which appears to exceed the specified tolerance shall be slumped in accordance with ASTM C 143. Concrete which is determined to exceed the maximum allowable slump shall be returned to the batch plant and wasted at no additional cost to the Government. All slumps, both visual and physical, shall be recorded as required by the Construction Control Manual.

3.5.1 Chutes

When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

3.5.2 Buckets

Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3.5.3 Belt Conveyors

Belt conveyors may be used when approved. Belt conveyors shall be designed for conveying concrete and shall be operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar. Conveyors shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

3.5.4 Pumps

Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.6 CONCRETE PLACEMENT

Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by the Government if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 29 degrees C, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the

truck.

3.6.1 Placing Operation

Concrete shall be handled from mixer 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. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 2.5 m 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 300 mm thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3.6.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm 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 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for 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 few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 100 mm 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.

3.6.3 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 4 degrees C. The temperature of the concrete when placed shall be not less than 10 degrees C nor more than 24 degrees C. 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, calcium chloride or chemical admixture conforming to ASTM C 494 Type C or E may be used. Any concrete damaged by inadequate protection or procedure shall be removed and replaced at no additional cost to the government.

3.6.4 Warm Weather Requirements

The temperature of the concrete placed during warm weather shall not exceed 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 35 degrees C.

3.7 CONSTRUCTION JOINTS

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 is no longer plastic, before placing concrete for beams, girders, or slabs thereon. In walls having door 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 are required, a strip of 25.4 mm (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 25 mm 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 PREPARATIONS OF SURFACES.

3.8 FINISHING CONCRETE

3.8.1 Formed Surfaces

3.8.1.1 Repair of Surface Defects

Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 25 mm, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by the Contracting Officer and finished slightly higher than the surrounding surface. For Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 10 degrees C while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed.

3.8.1.2 Class B Finish

Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.

3.8.1.3 Class C Finish

Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.

3.8.1.4 Class D Finish

Where a Class D finish is indicated, fins exceeding 6 mm in height shall be chipped or rubbed off. Concrete surfaces shall be left with the texture imparted by the forms used.

3.8.2 Unformed Surfaces

In cold weather, the air temperature in areas where concrete is being finished shall not be less than 10 degrees C. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 1 kg per square meter per hour (0.2 per square foot per hour); coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 8 mm (5/16 inch) when tested with a 3.05 m (10 foot) straightedge. Floor tolerance measurements shall be made as soon as possible after finishing. When forms or shoring are used the measurements shall be made prior to their removal. Surfaces shall be pitched to drains.

3.8.2.1 Rough-Slab Finish

Slabs to receive fill or mortar setting beds shall be screeded with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

3.8.2.2 Float Finish

Slabs to receive a steel trowel finish shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections. Float finish is normally specified for surfaces that will receive other treatment such as built-up roofing, nonslip surfacing material or other types of dry-shake surface. It should not be specified as a wearing surface.

3.8.2.3 Trowel Finish

Slabs shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs 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. A final hard steel troweling shall be done by hand. Trowel finish will be specified for most wearing surfaces and where a smooth finish is required.

3.8.2.4 Broom Finish

After floating, slabs, where indicated, shall be lightly trowelled, and then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.9 CURING AND PROTECTION

3.9.1 General

All concrete shall be cured by an approved method for the period of time given below:

Concrete with Type II, IP or IS cement	7 days
Concrete with Type II cement blended with pozzolan	7 days

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C for the first 3 days and at a temperature above 0 degrees C 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. All 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 shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved, except that all slabs shall be moist cured for the first 24 hours.

3.9.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 50 mm minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3.9.3 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except 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. Surfaces shall be thoroughly moistened with water and the 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. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. 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. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. 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.

3.10 FLOOR HARDENER

The following following rooms 141 (Mechanical), 146 (Electrical), and 187 (Battery) 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, 0.5 kg of the silocofluoride shall be dissolved in 4 liters of water. For subsequent applications, the solution shall be 1.0 kg of silicofluoride to each 4 liters 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 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 20 mm. 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.

3.11.1 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.

3.11.2 Nonshrink Grout

Nonshrink grout shall be mixed and placed in accordance with material manufacturer's written recommendations. Forms of wood or other suitable material shall be used to retain the grout. The grout shall be placed quickly and continuously, completely filling the space without segregation or bleeding of the mix.

3.12 CONSTRUCTION QUALITY CONTROL

Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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DIVISION 04 - MASONRY

SECTION 04200

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SECTION 04200

MASONRY

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 SP-66	(1994) ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1994) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615	(1995) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 90	(1995) Loadbearing Concrete Masonry Units
ASTM C 91	(1995) Masonry Cement
ASTM C 270	(1995) Mortar for Unit Masonry
ASTM C 476	(1991) Grout for Masonry
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 641	(1982; R 1991) Staining Materials in Lightweight Concrete Aggregates
ASTM C 780	(1994) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 1019	(1989a; R 1993) Sampling and Testing Grout
ASTM C 1072	(1994) Measurement of Masonry Flexural Bond Strength
ASTM D 2000	(1990; R 1994) Rubber Products in Automotive Applications
ASTM D 2240	(1991) Rubber Property - Durometer Hardness

ASTM D 2287	(1992) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 447	(1992b) Compressive Strength of Masonry Prisms

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Concrete Masonry Units; GAFIO.

Manufacturer's descriptive data.

SD-04 Drawings

Masonry Work; FIO.

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; 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 to 50. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-08 Statements

Cold Weather Installation; FIO.

Cold weather construction procedures.

SD-09 Reports

Efflorescence Test; FIO. Field Testing of Mortar; FIO. Field Testing of Grout; FIO. Prism tests; FIO. Masonry Cement; FIO.

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; FIO.

Copies of masonry inspector reports.

SD-13 Certificates

Concrete Masonry Units (CMU); FIO. Control Joint Keys; FIO. Anchors, Ties, and Bar Positioners; FIO. Expansion-Joint Materials; FIO. Joint Reinforcement; FIO. Reinforcing Steel Bars and Rods; FIO. Masonry Cement; FIO. Mortar Coloring; FIO. Precast Concrete Items; FIO. Mortar Admixtures; FIO. Grout Admixtures; FIO.

SD-14 Samples

Concrete Masonry Units (CMU); FIO.

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.

Anchors, Ties, and Bar Positioners; FIO.

Two of each type used.

Expansion-Joint Material; FIO.

One piece of each type used.

Joint Reinforcement; FIO.

One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

1.3 SAMPLE MASONRY PANELS

After material samples are approved and prior to starting masonry work, 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 L-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 or a leg of an L-shaped panel shall be 2.5 m long by 1.8 m 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,flashing, row lock courses and weep holes shall be shown in the sample panels. The panels shall contain a masonry bonded corner that includes a bond beam corner. Panels shall show parging and

installation of electrical boxes and conduit. Panels that represent reinforced masonry shall contain a 600 mm by 600 mm opening placed at least 600 mm above the panel base and 600 mm away from all free edges, corners, and control joints. Required reinforcing shall be provided around this opening as well as at wall corners and control joints.

1.3.3 Construction Method

Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to 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 and shall conform to the moisture content as specified in ASTM C 90 when delivered to the jobsite. 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 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.

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 CONCRETE MASONRY UNITS (CMU)

Hollow concrete masonry units shall conform to ASTM C 90, Type I, Grade N-I, design f'm = 10 MPa, Medium weight. Cement shall have a low alkali content and be of one brand.

2.2.1 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.

2.2.2 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 25 mm . Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.2.2.1 Architectural Units

Units shall have patterned face shell. Face shell pattern shall be split faced. Units shall be integrally colored during manufacture. Color shall be as indicated on the drawings. Patterned face shell shall be properly aligned in the completed wall.

2.3 PRECAST CONCRETE ITEMS

Trim, lintels, door or window sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 28 MPa minimum conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE using 13 mm to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 20 mm 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 827 kPa 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 35 kg 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.

2.3.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 15M 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.

2.3.2 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 6 mm allowance for mortar joints. The ends of sills, except a 20 mm wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings.

2.3.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

2.4 MORTAR

Mortar shall be Type S in accordance with the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; 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. Evaluation of 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. Mortar shall have a minimum compressive strength of 12.0 MPa at 28 days.

2.4.1 Admixtures

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, Type C.

2.4.2 Coloring

Mortar coloring shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching the block color. Mortar coloring shall not exceed 3 percent of the weight of cement for carbon black and ten percent of the weight of cement for all other pigments. 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.

2.5 GROUT

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and 250 mm. 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. Grout shall have a minimum compressive strength of 14.0 MPa at 28 days.

2.5.1 Admixtures

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, Type C.

2.5.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.6 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, 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 16 mm mortar cover from either face.

2.6.1 Dovetail Anchors

Dovetail anchors shall be of the flexible wire type, 5 mm diameter zinc-coated steel wire, triangular shaped, and attached to a 2.69 mm or heavier steel dovetail section. These anchors shall be used for anchorage of 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.

2.6.2 Adjustable Anchors

Adjustable anchors shall be 5 mm diameter steel wire, triangular-shaped. Anchors attached to steel shall be 8 mm diameter steel bars placed to provide 2 mm 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.

2.6.3 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 3.76 mm steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.7 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Wire shall have zinc coating conforming to ASTM A 153, Class B-2. All wires shall be a minimum of 3.76 mm. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units . Joint reinforcement shall be placed a minimum of 16 mm cover from either face. The distance between crosswires shall not exceed 400 mm . Joint reinforcement for straight runs shall be furnished in flat sections not less than 3 m long. Joint reinforcement shall be provided with factory formed corners and intersections.

2.8 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615, Grade 60.

2.9 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 2000or 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 16 mm thick and 10 mm thick flanges, with a tolerance of plus or minus 2 mm . 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 34 degrees C after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.10 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 07920 JOINT SEALING.

2.11 FLASHING

Flashing shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.12 WEEP HOLE VENTILATORS

Weephole ventilators shall be prefabricated aluminum grill type vents designed to prevent insect entry with maximum air entry. Ventilators shall be sized to match modular construction with a standard 10 mm mortar joint.

PART 3 EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 37 degrees C in the shade and the relative humidity is less than 50 percent. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 1.2 m 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 4 degrees C, 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 Preparation

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 4 to 0 degrees C. Sand or mixing water shall be heated to produce mortar temperatures between 4 degrees C and 49 degrees C.

b. Air Temperature 0 to minus 4 degrees C. Sand and mixing water shall be heated to produce mortar temperatures between 4 degrees C and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature minus 4 to minus 7 degrees C. Sand and mixing water shall be heated to provide mortar temperatures between 4 degrees C and 49 degrees C. 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 24 km/hour.

d. Air Temperature minus 7 degrees C and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 degrees C and 49 degrees C. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C. Temperature of units when laid shall not be less than minus 7 degrees C.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 4 degrees C to 0 degrees C. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 0 degrees C to minus 4 degrees C. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature minus 4 degrees C to minus 7 degrees C. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature minus 7 degrees C and Below. Masonry temperature shall be maintained above 0 degrees C for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.2 LAYING MASONRY UNITS

Masonry units shall be laid in running bond pattern. 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. Expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be free from 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. Units shall be shoved into place so that the vertical joints are tight. 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 13 mm into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

3.2.1 Surface Preparation

Surfaces upon which masonry is 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 3 mm. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.2 Forms and Shores

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.

3.2.3 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. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.4 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. 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	
In adjacent masonry units	3 mm
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 6 m	6 mm
In 12 m or more	13 mm
Variation from level for bed joints and top surfaces of bearing walls	
In 3 m	6 mm
In 12 m or more	13 mm
Variations from horizontal lines	
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm
Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	6 mm
Plus	13 mm

3.2.5 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 300 mm wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.6 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:

3.2.6.1 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. Flush joints for architectural units, such as split faced units, shall completely fill both the head and bed joints.

3.2.6.2 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.

3.2.6.3 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 10 mm. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm.

3.2.7 Joint Widths

Joint widths shall be as follows:

3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 10 mm joints.

3.2.8 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.

3.2.9 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing 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.

3.2.10 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.

3.2.11 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 100 mm 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 masonry walls over 100 mm 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 WEEP HOLES

Weep holes shall be provided not more than 600 mm on centers in mortar joints above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be constructed using weep hole ventilators. Other approved methods may be used for providing weep holes. Weep holes shall be kept free of mortar and other obstructions.

3.4 SPLASH BLOCKS

Splash blocks shall be located as shown.

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 2-1/2 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 50 mm 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 13 mm 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 192 diameters of the reinforcement. 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.

3.7 JOINT REINFORCEMENT

Joint reinforcement shall be installed at 400 mm on center or as indicated. Reinforcement shall be lapped not less than 150 mm. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 16 mm cover to either face of the unit.

3.8 PLACING GROUT

All masonry cells shall be filled solid 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 10 m 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 400 mm on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 100 mm in diameter or 75 by 100 mm 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 1.5 m. 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 800 mm 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 75 by 100 mm 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.

3.8.4 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 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 1.5 m in height. High-lift grout methods shall be used on

pours exceeding 1.5 m 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 13 mm into the grout space shall be removed before beginning the grouting operation. Grout pours 300 mm or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 300 mm 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 6 mm 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 1.2 m 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 300 to 450 mm 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 (m) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (mm) (1,2) Multiwythe Masonry (3)	Hollow-unit Masonry
0.3	Fine	Low Lift	20	40 x 50
1.5	Fine	Low Lift	50	50 x 75
2.4	Fine	High Lift	50	50 x 75
3.6	Fine	High Lift	65	65 x 75
7.3	Fine	High Lift	75	75 x 75
0.3	Coarse	Low Lift	40	40 x 75
1.5	Coarse	Low Lift	50	65 x 75
2.4	Coarse	High Lift	50	75 x 75
3.6	Coarse	High Lift	65	75 x 75
7.3	Coarse	High Lift	75	75 x 100

Notes:

(1) The actual grout space or cell dimension must be larger than the sum of the following items:
a) The required minimum dimensions of total clear areas given in the table above;
b) The width of any mortar projections within the space;
c) 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 20 mm or greater in width.

(3) 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 13 mm 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. 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 exterior masonry walls, the exterior control joints shall be raked to a depth of 20 mm; backer rod and sealant shall be installed in accordance with Section 07920 JOINT SEALING. Exposed interior control joints shall be raked to a depth of 6 mm. Concealed control joints shall be flush cut.

3.11 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 3 m and installed with a 6 mm gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 1.2 m, unless limited by wall configuration.

3.12 LINTELS

3.12.1 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. 15M 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 600 mm, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 15 mm above the bottom inside surface of the lintel unit.

3.12.2 Precast Concrete 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. Precast concrete and steel lintels shall have a minimum bearing length of 200 mm unless otherwise indicated on the drawings.

3.13 PRECAST SILLS

Precast sills shall be set in a full bed of mortar with faces plumb and true.

3.14 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.14.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 400 mm on centers vertically and 600 mm on center horizontally.

3.14.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 400 mm on centers vertically, and if applicable, not over 600 mm on centers horizontally.

3.15 PARGING

The outside face of below-grade exterior concrete-masonry unit walls

enclosing usable rooms and spaces, except crawl spaces, shall be parged with type S mortar. Parging shall not be less than 13 mm thick troweled to a smooth dense surface so as to provide a continuous unbroken shield from top of footings to a line 150 mm below adjacent finish grade, unless otherwise indicated. Parging shall be coved at junction of wall and footing. Parging shall be damp-cured for 48 hours or more before backfilling. Parging shall be protected from freezing temperatures until hardened.

3.16 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.

3.16.1 Concrete Masonry Unit Surfaces

Exposed concrete masonry unit 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 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 03300CAST-IN-PLACE STRUCTURAL CONCRETE.

3.18 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 600 mm 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.

3.19 TEST REPORTS

3.19.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 13 to 16 mm 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.

3.19.2 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 13.8 MPa at 28 days.

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SECTION 05120

STRUCTURAL STEEL

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 LRFD, Vol I	(1993) Load & Resistance Factor Design Manual, Vol 1 - Structural Members, Specifications and Codes
AISC LRFD, Vol II	(1993) Load & Resistance Factor Design Manual, Vol II - Connections
AISC-04	(1989) Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design
AISC S303	(1992) Code of Standard Practice for Steel Buildings and Bridges
AISC S329	(1986) Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6	(1995c) General Requirements for Rolled Structural Bars, Plates, Shapes, and Sheet Piling
ASTM A 36	(1994) Carbon Structural Steel
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(1994) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(1994) Carbon and Alloy Steel Nuts
ASTM F 436	(1993) Hardened Steel Washers
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1	(1985) Surface Texture (Surface Roughness, Waviness and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1	(1994) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

1.2 GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC S329. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. AISC-04 with pertinent provisions of AISC LRFD, Vol I and AISC LRFD, Vol II shall govern the work. Welding shall be in accordance with AWS D1.1. High-strength bolting shall be in accordance with AISC S329.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Structural Steel System; FIO. Structural Connections; GA.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.

SD-08 Statements

Erection; FIO.

Erection plan of the structural steel framing required. Erection plan shall conform to the requirements of AISC S303, shall be submitted prior to erection, and shall describe all necessary temporary supports, including the sequence of installation and removal.

SD-13 Certificates

Mill Test Reports; FIO.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items.

Welder Qualifications; FIO.

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Fabrication; FIO.

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

SD-14 Samples

High Strength Bolts and Nuts; FIO. Carbon Steel Bolts and Nuts; FIO. Nuts Dimensional Style; FIO. Washers; FIO.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

1.4 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B .

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, Type S, Grade B.

2.4 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to ASTM A 325, Type 1 with carbon steel nuts conforming to ASTM A 563, Grade C.

2.5 CARBON STEEL BOLTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563, Grade A.

2.6 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Hex Style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325 bolts.

2.7 WASHERS

Plain washers shall conform to ASTM F 844. Other types, when required, shall conform to ASTM F 436.

2.8 PAINT

Paint shall conform to SSPC Paint 25.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC-04. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC quality certification program for Category I structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 12.7 micrometer as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6. 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 the AISC-04 and primed with the specified paint.

3.2 ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of AISC-04.

3.2.1 Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work.

3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. 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.

3.2.3 Field Welded Connections

Field welded structural connections shall be completed before load is applied.

3.2.4 Field Priming

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.

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SECTION 05210

STEEL JOISTS

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-01	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Joists; FIO.

Detail drawings shall include fabrication and erection details, specifications for shop painting, and identification markings of joists .

SD-13 Certificates

Steel Joists; FIO.

Certificates stating that the steel joists have been designed and manufactured in accordance with SJI-01. Complete engineering design computations may be submitted in lieu of the certification.

1.3 DESCRIPTION

Steel joists are designated on the drawings in accordance with the standard designations of the Steel Joist Institute. 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 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-01, K-Series.

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. For joists which will be finish painted under Section 09900 PAINTING, GENERAL, the primer paint shall be limited to a primer which is compatible with the specified finish paint.

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 12 m through 18 m one row of bridging nearest midspan shall be bolted diagonal bridging; for spans over 18 m 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 nonshrink grout . Nonshrink grout shall be as specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION.

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SECTION 05300

STEEL DECKING

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 IRON AND STEEL INSTITUTE (AISI)

AISI SG-01	(1986; Addenda 1989) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653	(1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.3	(1989) Structural Welding Code - Sheet Steel

STEEL DECK INSTITUTE (SDI)

SDI-02	(1987; Amended 1991) Diaphragm Design Manual
SDI Pub No 28	(1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

STEEL STRUCTURES PAINTING COUNCIL (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 "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Deck Units; FIO.

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

SD-04 Drawings

Deck Units; FIO. Accessories; FIO.
Attachments; FIO. Holes and Openings; FIO.

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-13 Certificates

Deck Units; FIO. Attachments; FIO.

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.

SD-14 Samples

Deck Units; FIO. Accessories; FIO.

A 0.19 sq meter sample of the decking material to be used, along with a sample of each of the accessories used.

SD-18 Statements

Attachments; FIO.

Prior to welding operations, copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

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 28. Panels of maximum possible lengths shall be used to minimize end laps. Fabricate deck units in

lengths to span 3 or more supports with flush, telescoped, or nested 50.8 mm laps 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 SG-01, 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 shall conform to ASTM A 653. Roof deck units shall be fabricated of the steel design thickness required by the design drawings and shall be galvanized zinc-coated in conformance with ASTM A 653, G90 coating class or aluminum-zinc coated in conformance with ASTM A 792 coating designation AZ55.

2.1.2 Sump Pans

Sump pans shall be provided for roof drains and shall be minimum 1.897 mm thick steel, recessed type. Sump pans shall be shaped to meet roof slope by the supplier or by a sheet metal specialist. Bearing flanges of sump pans shall overlap steel deck a minimum of 75 mm. Opening in bottom of pan shall be shaped, sized, and reinforced to receive roof drain.

2.2 TOUCH-UP PAINT

Touch-up paint for shop-painted units shall be of the same type used for the shop painting, and 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.

2.5 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, 1.204 mm ; welding washers, 1.519 mm ; cant strip, 0.749 mm ; other metal accessories, 0.909 mm ; 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 28 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 used for storage or as a working platform until the units have been secured in position. Shoring shall be in position before concrete placement begins in composite deck. 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 SHORING

Shoring requirements for placing and curing of concrete in the composite floor deck assemblies shall be as shown.

3.3 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 16 mm diameter puddle welds to supports as indicated on the design drawings and in accordance with requirements of SDI Pub No 28. 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. Deck ends shall be lapped 50 mm . All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of SDI-02.

3.4 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 150 mm across require no reinforcement. Holes and openings 150 to 300 mm across shall be reinforced by 1.204 mm thick steel sheet at least 300 mm wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 150 mm on center. Holes and openings larger than 300 mm shall be reinforced by steel angles 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.

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SECTION 05400

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SECTION 05400

COLD-FORMED METAL FRAMING

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 SG-673	(1986; Errata 1990) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/A 653M	(1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

AMERICAN WELDING SOCIETY, INC. (AWS)

AWS D1.3	(1989) Structural Welding Code - Sheet Steel

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

1.2.1 SD-02, Manufacturer's Catalog Data; FIO.

a. Studs, Tracks, Bracings, Purlins/Joists, and Struts

1.2.2 SD-04, Drawings; FIO.

a. Framing drawings

1.2.2.1 Drawing Requirements

Submit framing drawings to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.2.3 SD-05, Design Data; FIO.

a. Metal framing calculations

1.2.3.1 Data Required

Submit metal framing calculations to verify sizes, thickness, and spacing of members and connections. Show methods and practices used in installation.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to job site and store in adequately ventilated, dry locations. Storage area shall permit easy access for inspection and handling. If necessary to store materials outside, stack off the ground, support on a level platform, and protect from the weather as approved. Handle materials to prevent damage. Replace damaged items with new, as directed by the Contracting Officer.

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

Include top and bottom tracks, bracing, fastenings, and other accessories necessary for complete installation. Framing members shall be 1.3 mm thick. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads. Design framing in accordance with AISI SG-673.

1.5 MAXIMUM DEFLECTION

a. Studs, Tracks, and Bracings:

Deflection Criteria	Exterior Finish
L/240 or L/360	Synthetic Plaster, Metal Panels
L/360	Cement Plaster, Wood Veneer
L/600	Brick Veneer, Stone Panels

Wall deflections shall be computed on the basis that studs withstand all lateral forces independent of any composite action from sheathing materials. Studs abutting windows or louvers shall also be designed not to exceed 6.35 mm maximum deflection.

b. Roof Purlins:

L/240 - Live load only

PART 2 PRODUCTS

2.1 STUDS, TRACKS, BRACINGS, PURLINS/JOISTS, AND STRUTS

2.1.1 Studs, Tracks, Bracings, Purlins/Joists, and Struts of 1.5 mm and Heavier

Galvanized steel, ASTM A 653/A 653M, SQ Grade 50, G60.

2.1.2 Studs, Tracks, Bracings, Purlins/Joists, and Struts of 1.3 mm

Studs, Tracks, Bracings, Purlins/Joists, and Struts of 1.3 mm Track, and Accessories (All thicknesses): Galvanized steel, ASTM A 653/A 653M, SQ, Grade 345 230 MPa G60.

2.1.3 Sizes, Thicknesses, Section Modulus, and Other Structural Properties

Studs shall be stamped with manufacturer's name, initials, or logo, an ICBO number, material thickness and yield strength. Size and thickness as indicated.

2.2 PLASTIC GROMMETS

Supply plastic grommets, recommended by stud manufacturer, to protect electrical wires. Prevent metal to metal contact for plumbing pipes.

PART 3 EXECUTION

3.1 FASTENING

Fasten framing members together by welding or by using self-drilling or self-tapping screws. Welding shall conform to AWS D1.3 welding procedure. Electrodes and screw connections shall be as required and indicated in the design calculations. Do not field weld materials lighter than 1.2 mm.

3.2 TRACKS

Provide accurately aligned runners at top and bottom of partitions. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 75 mm from the edge of concrete slabs.

3.3 STUDS

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 600 mm wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI SG-673, consisting of, as a minimum, runner channel cut to fit between and welded to the studs or hot- or cold-rolled steel channels inserted through cutouts in web of each stud and secured to studs with welded clip angles. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING
Wind load only	Up to 3000 mm	One row at mid-height
	Over 3000 mm	Rows 1500 mm o.c. maximum
Axial load	Up to 3000 mm	Two rows at 1/3 points
	Over 3000 mm	Rows 900 mm o.c. maximum

3.4 PURLINS/JOISTS

Bracing as indicated on the drawings.

3.5 ERECTION TOLERANCES

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

(1) Layout of walls and partitions: 6 mm from intended position;

(2) Plates and runners: 6 mm in 2400 mm from a straight line;

(3) Studs: 6 mm in 2400 mm out of plumb, not cumulative; and

(4) Face of framing members: 6 mm in 2400 mm from a true plane.

b. 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:

(1) Layout of walls and partitions: 6 mm from intended position;

(2) Plates and runners: 3 mm in 2400 mm from a straight line;

(3) Studs: 3 mm in 2400 mm out of plumb, not cumulative; and

(4) Face of framing members: 3 mm in 2400 mm from a true plane.

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DIVISION 05 - METALS

SECTION 05500

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SECTION 05500

MISCELLANEOUS METAL

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	(1980; R 1993) Designation System for Aluminum Finishes

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1996) Carbon Structural Steel
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 653	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924	(1996a) Steel Sheet, Metallic-Coated by the Hot-Dip Process

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-344	(Rev B) Lacquer, Clear Gloss, Exterior, Interior

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(1993) Metal Bar Grating Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Miscellaneous Metal Items; FIO.

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: Fire Extinguisher Cabinets

SD-14 Samples

Miscellaneous Metal Items; FIO.

Samples of the following items: Fire Extinguisher Cabinets. Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

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, ASTM A 653, or ASTM A 924, 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 anodized finish. The thickness of the coating shall be not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF-45. Items to be anodized shall receive a polished satin 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 DOWNSPOUT BOOTS

Downspout boots shall be cast iron with receiving bells sized to fit downspouts.

2.2 EXPANSION JOINT COVERS

Expansion joint covers shall be constructed of extruded aluminum with anodized satin finish for walls and ceilings and with standard mill finish for floor covers and exterior covers. Plates, backup angles, expansion filler strip and anchors shall be designed as indicated.

2.2.1 Elastomeric Seismic Joints

Seismic joints shall be elastomeric, permanently secured to a rigid metal frame, in accordance with FS TT-S-00227. Vinyl ceiling covers shall be dual durometer white vinyl extrusion

2.3 FLOOR GRATINGS AND FRAMES

Carbon steel grating shall be designed in accordance with NAAMM MBG 531 to meet the indicated load requirements. Edges shall be banded with bars 6 mm less in height than bearing bars for grating sizes above 19 mm. Banding bars shall be flush with the top of bearing grating. Frames shall be of welded steel construction finished to match the grating. Floor gratings

and frames shall be galvanized after fabrication.

2.4 HANDRAILS

Handrails shall be designed to resist a concentrated load of 890 N in any direction at any point of the top of the rail or 292 Newtons per meter applied horizontally to top of the rail, whichever is more severe.

2.4.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, shall be steel pipe conforming to ASTM A 53 or structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength. Steel railings shall be 40 mm nominal size. Railings shall be hot-dip galvanized and shop painted. Pipe collars shall be steel.

a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

   (1) Flush type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 10 mm hexagonal recessed-head setscrews.

   (2) 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 150 mm long.

   (3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

b. Removable sections, toe-boards, and brackets shall be provided as indicated.

2.5 MIRROR FRAMES

Frames for plate glass mirrors larger than 450 by 750 mm shall be fabricated from corrosion-resisting steel with satin finish. Frames shall be provided with concealed fittings and tamperproof mountings.

2.6 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.

2.7 SHELVING

Shelving shall conform to FS AA-S-271, Kind 1, Class 2, type V. Minimum dimensions and number of shelves shall be as indicated.

2.8 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, grating treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36. Stairs and accessories shall be galvanized. Gratings for treads and landings shall conform to NAAMM MBG 531. Grating treads shall have slip-resistant nosings.

2.9 STEEL DOOR FRAMES

Steel door frames built from structural shapes shall be neatly mitered and securely welded at the corners with all welds ground smooth. Jambs shall be provided with 50 by 6 by 300 mm bent, adjustable metal anchors spaced not over 760 mm on centers. Provision shall be made to stiffen the top member for all spans over 900 mm. Continuous door stops shall be made of 38 by 16 mm bars.

2.10 WINDOW SUB-SILL

Window sub-sill shall be of extruded aluminum alloy of size and design indicated. Not less than two anchors per window section shall be provided for securing into mortar joints of masonry sill course. Sills for banks of windows shall have standard mill finish with a protective coating, prior to shipment, of two coats of a clear, colorless, methacrylate lacquer applied to all surfaces of the sills.

2.11 FIRE EXTINGUISHER CABINETS

Fire extinguisher cabinets for 4.5 kg dry chemical fire extinguisher shall be semi-recessed as indicated. Cabinet box shall be 18 gauge steel with a baked enamel fiish. Steel door and trim shall be one-piece construction with a continuous hinge. Trim shall be rolled edge and finished in baked enamel to match adjacent wall color. Door frame shall be 15.4 mm thick, one-piece hollow stell, full glazed steel frame with rubber roller catch and satin finish door handle, and have a baked enamel finish to match adjacent wall color.

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 REMOVABLE ACCESS PANELS

A removable access panel not less than 300 by 300 mm shall be installed directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

3.3 INSTALLATION OF DOWNSPOUTS

Downspouts shall be secured to building through integral lips with appropriate fasteners.

3.4 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

3.4.1 Installation of Steel Handrails

Installation shall be base plates bolted to stringers or structural steel

framework. Rail ends shall be secured by steel pipe flanges anchored by expansion shields and bolts.

3.5 DOOR FRAMES

Door frames shall be secured to the floor slab by means of angle clips and expansion bolts. Continuous door stops shall be welded to the frame or tap screwed with countersunk screws at no more than 450 mm centers, assuring in either case full contact with the frame. Any necessary reinforcements shall be made and the frames shall be drilled and tapped as required for hardware.

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SECTION 06100

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SECTION 06100

ROUGH CARPENTRY

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 AND PAPER ASSOCIATION (AFPA)

AFPA-T901	(1991; Supple 1993; Addenda Apr 95) National Design Specification for Wood Construction
AFPA T11-WCD1	(1988) Manual for Wood Frame Construction

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995) Basic Hardboard
AHA A194.1	(1985) Cellulosic Fiberboard

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC-01	(1994) Timber Construction Manual
AITC 109	(1990) Standard for Preservative Treatment of Structural Glued Laminated Timber
AITC 111	(1979) Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection
AITC ANSI/AITC-190.1	(1992) Wood Products - Structural Glued Laminated Timber

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A208.1	(1993) Particleboard

APA-THE ENGINEERED WOOD ASSOCIATION (APA)

APA Form E30	(1996) Design/Construction Guide, Residential and Commercial
APA E445	(1991; Rev Jan 1996) Performance Standards and Policies for Structural-Use Panels
APA EWS R540 Glulam Beams	(1996) Proper Storage and Handling of

APA EWS T300	(1997) Glulam Connection Details
APA V450	(1994; Rev Apr 1996) Source List - Adhesives for APA Glued Floor System

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM C 79	(1994) Gypsum Sheathing Board
ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM C 516	(1980; R 1990) Vermiculite Loose Fill Thermal Insulation
ASTM C 518	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties By Means of the Heat Flow Meter Apparatus
ASTM C 549	(1981; R 1995) Perlite Loose Fill Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 665	(1994) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 726	(1993) Mineral Fiber Roof Insulation Board
ASTM C 739	(1991) Cellulosic Fiber (Wood-Base) Loose-Fill Thermal Insulation
ASTM C 764	(1994) Mineral Fiber Loose-Fill Thermal Insulation
ASTM C 1013	(1994) Faced Rigid Cellular Polyisocyanurate Roof Insulation
ASTM C 1136	(1992) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1289	(1995) Faced Rigid Cellular
ASTM D 2898	(1994) Accelerated Weathering of

	Fire-Retardant-Treated Wood for Fire Testing
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 154	(1988; R 1993) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C9	(1995) Plywood - Preservative Treatment by Pressure Processes
AWPA C20	(1993) Structural Lumber Fire-Retardant Pressure Treatment
AWPA C27	(1993) Plywood - Fire-Retardant Pressure Treatment
AWPA M4	(1995) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(1996) Standards for Waterborne Preservatives

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA-01	(1995) Standard Specifications for Grades of California Redwood Lumber

CODE OF FEDERAL REGULATION (CFR)

16 CFR 1209	Interim Safety Standard for Cellulose Insulation

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood
DOC PS 2	(1992) Performance Standards for Wood-Based Structural-Use Panels

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825c	(1997) Approval Guide Building Materials

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA-01	(1994) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA-01	(1993) Standard Grading Rules for Northeastern Lumber

SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

SCMA-01	(1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB-1001	(1994) Standard Grading Rules for Southern Pine Lumber

TRUSS PLATE INSTITUTE (TPI)

TPI 1	(1995) National Design Standard for Metal Plate-Connected Wood Truss Construction and Commentary and Appendices to TPI 1

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB Std 17	(1993) Supples III (A), V (A), & VI (A)) Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01	(1995; Supple Nos. 1, 2, and 3) Western Lumber Grading Rules 95

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:
Nailers and Nailing Strips; FIO.

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

SD-13 Certificates

Grading and Marking; FIO.

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; FIO.

Certificate attesting that the cellulose, perlite, glass and mineral fiber, polyurethane, or polyisocyanurate 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. Laminated timber shall be handled and stored in accordance with AITC 111 or APA EWS R540.

PART 2 PRODUCTS

2.1 LUMBER AND SHEATHING

2.1.1 Grading and Marking

2.1.1.1 Lumber Products

Solid sawn and finger-jointed lumber shall bear an authorized gradestamp or grademark recongnized 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 and other Sheathing 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 structural-use 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 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:

100 mm or less, nominal thickness, 19 percent maximum. 125 mm or more, nominal thickness, 23 percent maximum in a 75 mm perimeter of the timber cross-section.

b. Roof Planking: 15 percent maximum.

c. Materials Other Than Lumber: In accordance with standard under which product is produced.

2.1.4 Sheathing

Sheathing shall be fiberboard, gypsum board, plywood, structural-use panels, or wood for wall sheathing; and plywood, structural-use panels, or wood for roof sheathing.

2.1.4.2 Gypsum Board

Gypsum board shall conform to ASTM C 79, 13 mm thick , 1200 mm wide with straight edges for supports 400 mm on center without corner bracing of framing or for supports 600 mm on center with corner bracing of framing; 600 mm wide with V-tongue and groove edges for supports 400 or 600 mm on center with corner bracing of framing.

2.1.5 Miscellaneous Wood Members

2.1.5.1 Nonstress Graded Members

Members shall include bridging, corner bracing, furring, grounds, and nailing strips. Members shall be in accordance with TABLE I for the species used. Sizes shall be as follows unless otherwise shown:

Member	Size mm (inch)
Furring	25 x 50 and 75
Grounds	Plaster thickness by 38.
Nailing strips	25 x 75 or 25 x 100 when used as shingle base or interior finish, otherwise 50 mm (2 inch) stock.

2.1.5.2 Sill Plates

Sill plates shall be standard or number 2 grade.

2.1.5.3 Blocking

Blocking shall be 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 Expansion Shields

Type and size best suited for intended use.

2.2.4 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 25 mm into supports. In general, 8-penny or larger nails shall be used for nailing through 25 mm thick lumber and for toe nailing 50 mm thick lumber; 16-penny or larger nails shall be used for nailing through 50 mm thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AFPA T11-WCD1. 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 AFPA-T901. 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 24 degrees C 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, Rolls and Acoustical

Glass fiber batts and rolls shall conform to ASTM C 665, Type II kraft faced insulation or Type III foil faced insulation, Class A, 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.

2.3.2 Rigid Insulation

2.3.2.1 Polystyrene Board

Polystyrene board shall be extruded and conform to ASTM C 578, Type IV.

2.4 VAPOR RETARDER

Vapor retarder shall be polyethylene sheeting conforming to ASTM E 154or other equivalent material. Vapor retarder shall have a maximum vapor permeance rating of 29 ng per Pa per second per square meter as determined in accordance with ASTM E 96, unless otherwise specified.

PART 3 EXECUTION

3.1 INSTALLATION OF FRAMING

3.1.1 General

Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Members shall be framed for passage of ducts. Members shall be cut, notched, or bored in accordance with applicable requirements of AFPA-T901 for the passage of pipes, wires, or conduits.

3.2 INSTALLATION OF SHEATHING

3.2.2 Gypsum Board

Sheathing shall be applied with edges in light contact at joints and nailed in accordance with the manufacturer's approved instructions. Sheets 600 mm wide shall be applied horizontally with tongued edge up, with vertical joints over supports, and with vertical joints staggered. Sheets 1200 mm wide shall be applied vertically, extended over top and bottom plates, and with all vertical and horizontal joints over supports.

3.3 INSTALLATION OF MISCELLANEOUS WOOD MEMBERS

3.3.2 Blocking

Blocking shall be provided as necessary for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide firestopping. Blocking for firestopping shall ensure a maximum dimension of 2400 mm for any concealed space. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

3.3.3 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 450 mm on center and staggered. Beginning and ending nails shall not be more than 150 mm for nailer end. Ends of stacked nailers shall be offset approximately 300 mm 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 FM P7825c.

3.3.4 Wood Grounds

Wood grounds shall be provided as necessary for attachment of trim, finish, and other work to plaster. Grounds shall be run in lengths as long as practicable, butt jointed, and rigidly secured in place.

3.3.5 Furring Strips

Furring strips shall be provided at the locations shown. Furring strips shall be installed at 400 mm on center unless otherwise shown, run in

lengths as long as practicable, butt jointed and rigidly secured in place.

3.3.6 Sill Plates

Sill plates shall be set level and square and anchor bolted at not more than 1800 mm on centers and not more than 300 mm from end of each piece. A minimum of two anchors shall be used for each piece.

3.4 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 thermal resistance shown. For acoustical insulation the installed thickness shall be as shown. 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.

3.5 INSTALLATION OF VAPOR RETARDER

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. Joints in the vapor retarder shall be lapped and sealed according to the manufacturer's recommendations.

3.6 INSTALLATION OF AIR INFILTRATION BARRIER

Air infiltration barrier shall be installed in accordance with the manufacturer's recommendations.

TABLE I. SPECIES AND GRADE

Subflooring, Roof Sheathing, Wall Sheathing, Furring

Grading Rules	Species	Const Standard	No. 2 Comm	No. 2 Board Comm	No. 3 Comm
WCLIB Std 17					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Sitka Spruce	X			
	Mountain Hemlock	X			
	Western Cedar	X			
WWPA-01					
	Douglas Fir-Larch	X			
	Hem-Fir	X			
	Idaho White Pine	X			
	Lodgepole Pine			X	
	Ponderosa Pine			X	
	Sugar Pine			X	
	Englemann Spruce			X	
	Douglas Fir South			X	
	Mountain Hemlock			X	
	Subalpine Fir			X	
	Western Cedar			X	

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SECTION 06200

FINISH CARPENTRY

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 A135.6	(1990) Hardboard Siding

APA-THE ENGINEERED WOOD ASSOCIATION (APA)

APA E445	(1991; Rev May 1991) Performance Standards and Policies for Structural-Use Panels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1435	(1994) Outdoor Weathering of Plastics
ASTM D 2898	(1994) Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D 3679	(1994) Rigid Poly(Vinyl Chloride) (PVC) Siding
ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C9	(1995) Plywood - Preservative Treatment by Pressure Processes
AWPA C20	(1993) Structural Lumber Fire-Retardant Pressure Treatment
AWPA C27	(1993) Plywood - Fire-Retardant Pressure Treatment
AWPA M4	(1995) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(1996) Standards for Waterborne Preservatives

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI-02	(1994) Architectural Woodwork Quality

Standards, Guide Specifications and Quality Certification Program

CALIFORNIA REDWOOD ASSOCIATION (CRA)

CRA-01 (1995) Standard Specifications for Grades of California Redwood Lumber

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1996) Voluntary Product Standard - Construction and Industrial Plywood

DOC PS 2 (1992) Performance Standard for Wood-based Structural-Use Panels

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA-01 (1993) Standard Grading Rules for Northeastern Lumber

SOUTHERN CYPRESS MANUFACTURER'S ASSOCIATION (SCMA)

SCMA-01 (1986; Supple No. 1, Aug 1993) Standard Specifications for Grades of Southern Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB-1001 (1994) Standard Grading Rules for Southern Pine Lumber

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB Std 17 (1993; Supples III (A), V (A), & VI (A)) Grading Rules For West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01 (1995; Supple Nos. 1, 2, and 3)Western Lumber Grading Rules 95

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

WMMPA WM 6 (1987) Industry Standard for Non-Pressure Treating of Wood Millwork

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Finish Carpentry; FIO.

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-14 Samples

Moldings; FIO. Sills and Trim; FIO.

Samples shall be of sufficient size to show patterns, color ranges, and types, as applicable, of the material proposed to be used.

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), or 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, structural-use 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 Sills and Trim

2.1.4.1 Wood

Sills and trim shall be species and grade listed in TABLE I at the end of this section. Sizes shall be as indicated.

2.1.5 Moldings

Moldings shall be of the pattern indicated and shall be of a grade compatible with the finish specified.

2.1.6 Woodwork Items

2.1.6.1 Utility Shelving

Utility shelving shall be a suitable species equal to or exceeding requirements of No. 3 Common white fir under WWPA-01, 25 mm thick; or plywood, interior type, Grade A-B, 13 mm thick, any species group.

2.1.6.2 Workbench

Workbench shall have a work surface of 6 mm tempered hardboard over 50 mm thick lumber backing. Base shall be 2 mm steel with legs adjustable to 25 mm increments to adjust the work surface from 760 to 915 mm.

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 GENERAL

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. Window and door trim shall be provided in single lengths. 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 600 mm on center or as required to limit deflection to 6 mm between supports with a load of 525 N per meter. Adjustable shelf hardware shall be steel standards, channel shaped, with 25 mm adjustment slots and brackets designed for attachment to standards.

3.3.2 Workbenches

Items shall be anchored in place as indicated.

TABLE I. SPECIES AND GRADE TABLES

Grading Rules	Species	Choice	Clear	C Select	C & Better
WCLIB Std 17	Douglas Fir				X
	Larch				X
	Hemlock Fir				X
	Mountain Hemlock				X
	Sitka Spruce				X
WWPA-01	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 Std 17 shall be Grade B; and under WWPA-01, 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.

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SECTION 06410

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SECTION 06410

COUNTERS AND CASEWORK

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	(1996a) Surface Burning Characteristics of Building Materials

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI-02	(1994) Architectural Woodwork Quality Standards, Guide Specifications, and Quality Certification Program

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA A156.9	(1994) Cabinet Hardware

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1991) High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1286	(1993; Apr 1993) Office Furnishings

WOODWORK INSTITUTE OF CALIFORNIA (WIC)

(1995) Manual of Millwork

1.2 General

Work includes special fabricated cabinet units, countertops, prefinished surfaces, and preparation of site finishing. Casework shall conform to AWI and WIC quality standards. The Contractor shall coordinate the work of this section with that to be performed under other sections. This specification may include requirements that are not supplied by the casework manufacturer; any such requirements shall be furnished by the Contractor under this section.

1.3 Standards

All millwork shall be manufactured in accordance with the standards in the latest edition of the Manual of Millwork of the Woodwork Institute of CaliforniaandArchitectural Woodwork Institute in the grade or grades hereinafter specified or shown on the drawings.

1.4 Certification

Before delivery to the jobsite, the millwork supplier shall issue a WIC CertifiedandAWI Certified Compliance Certificate indicating the millwork products he will furnish for this job and certifying that they will fully meet all the requirements of the grade or grades specified. The shop drawings for the casework shall bear WIC Certified and AWI Certified Compliance Grade Stamp indicating the grade or grades specified. Each unit of casework shall bear the WIC CertifiedandAWI Certified Compliance Guide Stamp indicating the grade specified. Each plastic laminate countertop shall bear the WIC Certified Grade Stamp indicating the grade specified.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-04 Drawings

Cabinets; GA.

Shop drawings shall be submitted for approval in accordance with the requirements of shop drawings in the SPECIAL CLAUSES. Drawings shall show each cabinet work and related items and shall clearly indicate the complete layout of the cabinets and accessories.

Casework, including plastic laminate and solid surface benches shall include the following:

A. Indication of materials AWI and WIC grades.

B. Scale plan or plan section of each item, showing location.

C. Scale Elevations

D. Scale and/or full size sections to clarify special conditions, means of attachment, etc. Cabinet sectional details illustrated in this Manual need not be drawn on the shop drawings if referenced to the manual by Detail number and page.

E. Fixed dimensions, with provision for insertion of field dimensions in metric units.

F. The following items, when a part of the millwork contract shall be shown and/or described:

1. Hardware, showing location and schedule.

2. Metal Work, with details and locations.

3. Glass, showing installation.

4. Finishing or plastic overlays.

5. Erection methods and fastenings.

SD-14 Samples; GA

Two sets of the following samples. The Government reserves the right to reject any samples that do not satisfy the construction or color requirements. In lieu of individual samples, complete minimum size casework may be furnished as samples. Mock-up units are not acceptable. Samples shall be of sufficient size to show color, pattern, and method of assembly. The Contractor shall submit additional samples as required to obtain final approval. No work shall proceed without sample approval in writing from the Contracting Officer.

a. Counter top and backsplash - One section, containing both.

b. Door and drawer front - One of each, with hardware mounted.

c. Melamine plastic color samples approximately 50 by 75 mm size.

d. Stain/color samples shall be approximately 50 by 75 mm size.

1.6 Care and Storage of Casework

All casework shall receive the following care, storage and attention prior to installation by the contractor.

1.6.1 Delivery

Casework shall be delivered to the jobsite wrapped in a protective covering, but shall not be delivered until all drywall and concrete work is dry and the building is closed to the elements.

1.6.2 Storage

Casework shall be stored in a clean, well ventilated area that is free of dust, water, or other contaminates, stacked neatly, protected from direct sunlight, and excessive heat. Relative humidity should be at approximately 50% to 55% at 70 degrees C. Storage shall be in a manner to permit access for inspection and handling.

1.6.2.1 Casework Handling

Casework shall be handled carefully and set or stored on a level floor. Care shall be taken to protect the exposed finished portions from bumping, scratching, etc. Casework shall not be used for "work benches" or convenient places to store other materials.

1.6.2.2 Plastic Laminate Surfaces

Plastic laminate tops shall be stacked flat if possible, at least 100 mm off the floor, with a protective covering under the bottom unit, and covered on top to protect surfaces from scratching. Strips of wood or other suitable materials shall be placed between tops. If tops are fully-formed or have splashes attached, extreme care shall be taken to

prevent breaking. Never stand or stack plastic laminate tops on one end against a wall where they can be broken or damaged by falling.

PART 2 PRODUCTS

2.1 General Requirements for Casework

Casework shall be factory fabricated as scheduled on the architectural drawings, conforming to AWI and WIC quality standards, and the additional requirements specified herein. The Contractor shall furnish products which optimize design by reducing the amount of wood used (engineered wood), or 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 Casework: Natural Wood Finish

Casework shall be provided with a factory-applied durable finish of a type standard with the manufacturer. Natural finish wood doors, drawer fronts, cabinet fronts and exposed cabinet sides shall be fabricated of wood which will be free of extreme color variations within each panel or between adjacent panels. Exposed exterior surfaces shall be custom hardwood or hardwood veneer with natural stain and sprayed on polyurethane factory applied finish. Color shall be as indicated on the Finish Schedule in the architectural drawings.

2.1.2 Casework: Laminated Plastic Covered

Exposed surfaces of custom grade tempered hardboard, other than countertops, shall be faced with decorative high-pressure laminated plastic sheets a minimum of 0.71 mm in thickness. Door and drawer construction shall be flush overlay.

2.2 Countertops and Backsplashes

2.2.1 General

Countertops shall have no drip bullnose edge as shown on the drawings. Back splash shall be cove back splash. Top shall be fully-formed, height as shown. Color shall be as indicated on the Finish Schedule in the architectural drawings. Laminated thermosetting decorative sheets shall conform to NEMA LD 3.

2.2.2 Sink Rims

Sink rims shall be provided when required for the type sink specified in SECTION: Plumbing, General Purpose. Rims shall be the standard product of a manufacturer regularly producing sink rims, and shall be fabricated from corrosion-resistant steel.

2.2.3 Keyboards

Counters in the Crew Training Emulator rooms shall be capable of accepting an articulating keyboard at the worksurfaces as shown on the drawings. The keyboard shall have the capability to be fully recessed under the worksurface and extend to givethe user full access to the keyboard. Side travel rotation shall be 360-degrees. The keyboard pad shall have both positive and negative tilt capability, with friction lock levers to secure

the tray tilt and height position. Keyboard arm shall be constructed of steel. Keyboard tray shall be black melamine with a black padded urethane wrist rest.

2.3 Laminated Plastic Tops

Continuous sheets of longest lengths practical shall be provided. Joints in surface sheeting shall be tight and flush and held to a practical minimum. When countertop and backsplash are one unit, PF42 plastic laminate shall be used. Plastic laminate shall conform to the requirements of NEMA LD 3 and plastic laminate adhesive shall be contact type applied to both surfaces. For fully formed and cove type countertops, the post-forming plastic laminate shall not be bent to a radius smaller than the limit recommended by the plastic laminate manufacturer. Design, color and finish shall be as specified on the Finish Schedule in the architectural drawings.

2.4 Casework Hardware

All cabinet hardware shall be furnished and installed by the casework manufacturer. Hardware shall include all miscellaneous hardware for a complete installation.

2.4.1 Hardware Finish

Hinges and pulls shall be provided with a Satin chromium plated finish.

2.4.2 Casework Hardware

Casework hardware of the following types shall conform to BHMA A 156.11, Cabinet Locks and BHMA A 156.9, Cabinet Hardware as applicable.

2.4.2.1 Drawer Slides

Drawer slides shall be BHMA A 156.9, Type B05051 Satin chromium plated.

2.4.2.2 Shelf Standards and Brackets

BHMA A 156.9, Type B04112. Shelf standards shall be provided for shelves in the janitor's closets where indicated, BHMA A 156.9, Type B04102Satin chromium plated.

2.4.2.3 Hinges

BHMA A 156.9, Type B81602, concealed 652 Satin chromium plated.

2.4.2.4 Catches

BHMA A 156.9, Type B43171, magnetic 702 Satin chromium plated.

2.4.2.5 Pulls

BHMA A 156.9, Type B52011, wire pull 630 Satin stainless steel.

2.5 LOCKS AND KEYING

At least one drawer in the counter shall have a keyed lock. Field changeable lock cylinders shall be provided. Two keys shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION

Casework shall be located as indicated on the architectural drawings. The installation of the casework shall not damage the work of the other trades. All items shall be installed as required for proper operation in accordance with the manufacturer's directions. Prior to final acceptance, doors shall be aligned, hardware adjusted, and casework left in a clean neat condition.

3.1.1 Counters

Construct as indicated on the architectural drawings, plans and elevations. Height of countertops shall be as indicated. Units shall be secured with screws through backs to cleats that have been anchored to the building structure with toggle bolts. Conceal fastenings where practicable, fit the counter neatly, install in a rigid and substantial manner, and scribe to adjoining surfaces. Provide counter sections in the longest lengths practicable; keep joints in tops to a minimum; and where joints are necessary, provide tight hairline joints drawing up with concealed type heavy pull-up bolts. Glue joints with water resistant glue and, in addition, make rigid and substantial with screws, bolts, or other approved fastenings. Where required, toe space at front of counters shall be provided by installing front face of counters 75 mmin front of the base. Where toe space is not required face of base and counter shall be flush. Base shall have height of approximately 100 mm . Make cut-outs for fixtures to templates supplied by fixture manufacturer. Carefully locate cut-outs for pipes so that edges of holes will be covered by escutcheons. The inner edge of sink cut-outs in laminated plastic tops shall be painted with a coat of semigloss enamel paint and sink flanges shall be set in a bed of sealant. Closer and filler strips and finish moldings shall be provided as required.

3.1.2 Cabinets

Wall hung cabinets shall be installed to support the weight of the cabinets plus the normally expected weight of the contents of the cabinets. Install level, plumb and tight against adjacent walls, secure cabinets to walls with concealed toggle bolts. Fasteners shall be spaced 300 mm] on center using at least three bolts in each 900 mm or 1200 mm unit width.

3.2 CLEANING

Upon completion of installation, all products shall be cleaned and polished and the area shall be left in a clean and neat condition. Any defects in material and installation shall be repaired, and damaged products that cannot be satisfactorily repaired shall be replaced.

3.3 CONSTRUCTION QUALITY CONTROL

Attention is directed to Section 01440 CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

-- End of Section --

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DIVISION 06 - WOODS & PLASTICS

SECTION 06650

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SECTION 06650

SOLID SURFACE (POLYMER) FABRICATIONS

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 256	(1993a) Determining the Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D 570	(1981; R 1988) Test Method for Water Absorption of Plastics
ASTM D 638	(1994b) Test Method for Tensile Properties of Plastics
ASTM D 696	(1991) Test Method for Coefficient of Linear Thermal Expansion of Plastics
ASTM G 23	(1995) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM E 84	(1994a) Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1991) High Pressure Decorative Laminates

1.2 GENERAL

The work of this specification establishes the minimum requirement for the furnishing and installing of all solid surface (polymer) fabrications consisting of but not limited to sheet work, thermoforming and accessories as shown on drawings and in specifications and as required to complete work.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Products; FIO. Maintenance; FIO.

Product data shall indicate product description, fabrication information and compliance with specified performance requirement.

Maintenance data shall be submitted indicating manufacturer's care and maintenance data, including repair and cleaning instructions.

SD-04 Drawings

Shower Benches; GA.

Drawings shall indicate dimensions, component sizes, fabrication details, attachment provisions and coordination requirements with adjacent work.

SD-14 Samples

Shower Benches; GA.

Samples, minimum 150 mm by 150 mm, shall be submitted for approval. Samples shall indicate full range of color and pattern variation. Approved samples will be retained as a standard for this work.

1.4 QUALIFICATIONS

1.4.1 Manufacturer

Manufacturer of solid polymer materials shall be a company with not less than five (5) years of experience in supplying principle materials for solid surface (polymer) fabrication installations.

1.4.2 Fabricator

All work of this section shall be fabricated and installed by a fabrication professional who has been accredited by the manufacturer of the solid polymer materials. The accredited fabricator shall have a minimum of two (2) years of solid surface (polymer) fabrication experience and have completed a minimum of two (2) solid surface (polymer) fabrication projects of similar scope and size to this project.

1.5 DELIVERY, STORAGE AND HANDLING

Materials shall not be delivered to project site until areas are ready for installation. Materials shall be stored indoors, away from extreme temperatures. Handle all materials to prevent damage to finished surfaces. Protective coverings shall be provided to prevent physical damage or staining following installation and for the duration of the project.

1.6 WARRANTY

The Contractor shall warrant the materials provided, the materials shall not develop visible defects or otherwise fail due to manufacturing defects for ten (10) years. Warranties shall be signed by an authorized representatives of the manufacturer. The Contractor shall guarantee that the workmanship and installation is free from any defects from the date of delivery.

PART 2 PRODUCTS

2.1 COMPONENTS

Components shall be solid, non-porous polymer, not coated, laminated or of composite construction. Materials shall have mimimum physical and

performance properties specified. Superficial damage to a depth of 2.54 mm shall be repairable by sanding or polishing.

2.1.1 Material

Shower benches shall be 20 mm thick, to size and shape with edge details as indicated on the drawings. Provide benches with inconspicuous joints using manufacturer recommended structural adhesive. Surfaces shall not be affected by Class I reagents.

2.1.2 Colors

Colors shall be as indicated on the Finish Schedule in the architectural drawings.

2.1.3 Finish

Finish shall be manufacturer's standard matte or satin finish.

2.1.4 Edge Treatment

Edge treatment for tops shall be eased, rounded edges.

2.1.5 Performance Characteristics

PROPERTY	REQUIREMENT	TEST PROCEDURE
Tensile Strength	31,026 kPA	ASTM D 638
Tensile Modulus	6,894,760 kPA	ASTM D 638
Elongation	0.3% minimum	ASTM D 638
Hardness	55-60	(Barcol Impressor)
Gloss (60 degree Gardner)	5-18	NEMA LD 3, 3.15
Color Stability	No Effect	NEMA LD 3, 3.10
Flame Spread Smoke Developed	Class I	UL Molded Plastic 31E2
Water Absorption Weight (% maximum)	24 Hours = 0.015% Long Term = 0.09%	ASTM D 570
Izod Impact	0.33 - 0.41 N m	ASTM D 256
Impact Resistance (Falling Ball)	No Fracture 6 mm 914.4 mm drop 13 mm 914.4 mm drop	NEMA LD 3,3.03 0.22 kg ball 0.45 kg ball
Boiling Water Resistance	No Effect	NEMA LD 3, 3.05
High Temperature Resistance	No Change	NEMA LD 3, 3.06

Weatherability	No Change, 1000 Hours	ASTM G 23
Stain and Chemical Resistance	Passes, no lasting effect	NEMA LD 3, 3.09

2.2 ACCESSORY PRODUCTS

2.2.1 Seam Adhesive

Seam adhesive shall follow manufacturer's recommendations. Adhesives shall be color matched to solid surface (polymer) material. Adhesive shall create inconspicuous, non-porous joints.

2.2.2 Sealant

Sealant shall follow manufacturer's recommendations. Sealant shall be mildew resistant silicone sealant and color matched to solid surface (polymer) material. Sealant shall follow manufacturer's recommendations.

2.3 FABRICATION

Components shall be factory fabricated to the greatest extent practicable to sizes and shapes indicated, in accordance with approved shop drawings. Field dimensions shall be checked. If field dimensions cause fitting difficulties, procedure shall be presented to the Contracting Officer for approval. Joints shall be formed between components using manufacturer's standard joint adhesive. Defective and inaccurate work shall be rejected.

2.3.1 Thermoforming

Thermoforming shall comply with manufacturer's product data. Molds shall be constructed of plywood in "male/female" sections matching component shapes. Molds shall be shaped prior to seaming and joining. Pieces shall be cut to finished dimensions with edges sanded and nicks and scratches removed. Heat the entire component uniformly between 135-190.5 degrees C during forming. Prevent blistering, whitening and cracking of solid polymer material during forming. Defective material shall be rejected.

PART 3 EXECUTION

3.1 INSTALLATION

Components shall be installed plumb, level and rigid, scribed to adjacent finishes. Field joints shall be performed using specified color matched adhesives, with joints inconspicuous in the finished work.

3.2 PROTECTION

After fabrication and installation, protect surfaces of solid surface (polymer) fabrications from damage with protective coverings. Replace any damaged material.

3.3 CLEANING

All surfaces shall be cleaned to remove adhesives, sealants, paint and other contaminants.

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SECTION 07112

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SECTION 07112

BITUMINOUS WATERPROOFING

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 208	(1995) Cellulosic Fiber Insulating Board
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 173	(1997) Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
ASTM D 449	(1989; R 1994) Asphalt Used in Dampproofing and Waterproofing
ASTM D 1327	(1997) Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing
ASTM D 1668	(1995) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Reinforcing Fabric; FIO. Protection Board; FIO.

Manufacturer's data including technical information which indicates full compliance with this section.

SD-06 Instructions

Application; FIO.

Manufacturer's installation instructions, before delivery of materials to the site. Instructions shall specify acceptable range of asphalt application temperatures and the maximum temperature for holding asphalt in

a heated condition.

SD-13 Certificates

Materials; FIO.

Certificates from manufacturer attesting that asphalt manufactured and shipped to jobsite meets the specified requirements.

1.3 QUALIFICATIONS

Work shall be performed by skilled laborers thoroughly experienced in the type of bituminous waterproofing work specified to meet the requirements of the contract.

1.4 DELIVERY, STORAGE AND HANDLING

Waterproofing materials shall be delivered to the project site in the original sealed containers bearing the name of the manufacturer, contents and brand name. Asphalt shall be protected from freezing in a weathertight enclosure. Reinforcement fabrics shall be protected from moisture damage and moisture absorption in a weathertight enclosure or 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 waterproofing materials. Damaged or deteriorated materials shall be removed from project site.

PART 2 PRODUCTS

2.1 ASPHALT WATERPROOFING

2.1.1 Primer

Primer for hot-applied asphalt waterproofing shall conform to ASTM D 41, asbestos-free, non-fibrated, manufactured with highly ductile soft asphalts and selected hydrocarbons.

2.1.2 Above-Grade Hot-Applied Asphalt

For above-grade applications where asphalt will not be exposed to temperatures exceeding 50 degrees C, hot-applied asphalt for membrane waterproofing system shall conform to ASTM D 449, Type II. For above-grade applications where asphalt will be exposed to sunlight and temperatures exceeding 50 degrees C, hot-applied asphalt shall conform to ASTM D 449, Type III.

2.1.3 Below-Grade Hot-Applied Asphalt

Hot-applied asphalt for below-grade applications shall conform to ASTM D 449, Type I, asbestos-free, manufactured from crude petroleum, suitable for use with membrane waterproofing systems.

2.1.4 Reinforcement Fabrics

2.1.4.1 Cotton Fabrics

Cotton fabrics shall be woven entirely of cotton conforming with ASTM D 173, thoroughly and uniformly saturated with asphalt.

2.1.4.2 Woven Burlap Fabrics

Woven burlap fabrics shall be composed of 100 percent jute fiber and two cotton threads at each selvage conforming with ASTM D 1327, thoroughly and uniformly saturated with asphalt. The fabric mesh shall not be completely closed or sealed by the process of saturation. Sufficient porosity shall be maintained to allow successive moppings of the plying asphalt to seep through. The surface shall not be coated or covered with talc or any other substances that will interfere with the adhesion between fabric and plying asphalt. The fabric surface shall be uniformly smooth and free of irregularities, folds and knots. The finished woven burlap fabrics shall be free of ragged edges, untrue edges, breaks or cracks, and other visible external defects.

2.1.4.3 Glass Fabrics

Glass fabrics shall conform to ASTM D 1668 Type I, asphalt-treated woven glass waterproofing fabrics coated with asphalt.

2.1.5 Flashing Cement

Flashing cement shall conform to ASTM D 4586, Type I, trowel grade, asbestos free, manufactured from asphalts characterized as adhesive, healing and ductile.

2.2 INSULATION BOARDS

Insulation boards shall conform to ASTM C 208 cellulosic fiber boards, construction grade, 13 mm thick, fibrous-felted homogeneous panel. Insulation boards shall be manufactured from ligno-cellulosic fibers (wood or cane) by a felting or molding process, asphalt-saturated or coated, with a density of 49 to 151 kg per square meter . Surfaces of insulation boards shall be free of cracks, lumps, excessive departure from planeness, or other defects that adversely affect performance.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surfaces scheduled for bituminous waterproofing shall be prepared in accordance with waterproofing manufacturer's recommendations. Surface preparation shall be approved prior to waterproofing application.

3.1.1 Protection of Surrounding Areas

Before starting the waterproofing 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.

3.1.3 Concrete Surfaces

Surfaces shall be properly cured, free of form release agents, oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Form

ties shall be cut flush with surface. Sharp protrusions and form match lines shall be removed. Holes, voids, spalled areas and cracks which can damage waterproofing materials shall be repaired. Rough surfaces shall be parged with a well-adhering coat of cement mortar.

3.1.4 Metal Surfaces

Surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

3.2 HOT-APPLIED ASPHALT WATERPROOFING

Asphalt waterproofing shall be applied when the ambient temperature is 4 degrees C or above. Heating kettles and tanks shall be provided with automatic thermostatic control capable of maintaining asphalt temperature. Controls shall be calibrated and maintained in working order for duration of work. At time of application, asphalt shall not be heated above the equiviscous temperature (EVT) recommended by manufacturer. Immediately before use, temperature shall be measured with a portable thermometer at the point of application. EVT and flashpoint temperatures of asphalt in kettle shall be conspicuously posted on kettle. Asphalt with a temperature not conforming to the manufacturer's recommendations shall be returned to the kettle. Asphalt overheated by more than 10 degrees C for more than 1 hour shall be removed from site.

3.2.1 Below-Grade Wall Waterproofing

Waterproofing for foundation walls shall consist of a 3-ply hot-applied asphalt membrane system. Fabrics shall be installed using the "shingle" method. Joints shall be caulked prior to primer applications. Primer shall be applied at a rate of 0.2 liters per square meter . Fabrics shall be overlapped at ends and staggered a minimum 610 mm for 3-ply system. End-to-end taping is not acceptable. Each fabric shall be firmly embedded into a solid uniform coating of hot asphalt at a rate of 0.98 kg per square meter kg per square meter by pressing with broom. Fabrics shall not touch fabrics. Hot asphalt shall penetrate each fabric to provide the required adhesion. Asphalt between fabrics shall not be excessive to prevent slippage. Waterproofing system consisting of two or more fabrics shall be provided with fabric reinforcement at corners, angles, over construction joints, and in locations where waterproofing fabrics are subject to unusual stress.

3.3 CLEAN-UP

Surfaces of other work which are stained with waterproofing materials shall be cleaned with a cleaner recommended by waterproofing manufacturer.

3.4 PROTECTION OF COMPLETED WORK

3.4.1 Floor Waterproofing

The completed waterproofing work shall be protected from damage during and after construction. Protective covering shall be placed immediately before proceeding with the work which will conceal the waterproofing.

3.4.2 Wall Waterproofing

Waterproofing against which backfill is to be placed shall be protected with a single layer of insulation board. Insulation boards shall be pressed into the final mopping while the asphalt is still hot, with edges of boards placed into moderate contact and joints staggered. For two-layer installation, joints in second layer shall be staggered over joints in first layer. Where surfaced insulation board is used, the surfaced side shall face outward. Boards shall be carefully and neatly fitted around projections, and shall cover the entire surface of the waterproofing materials. Waterproofing system not covered with protection boards shall be protected to prevent damage from subsequent building operations. Installed boards shall not remain exposed at the end of a work day.

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SECTION 07180

WATER-REPELLENT SEALER FOR MASONRY

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SECTION 07180

WATER-REPELLENT SEALER FOR MASONRY

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 67	1980A)Sampling and Testing Brick and Structural Clay Tile
ASTM D 3278	1982)Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 96	1990)Water Vapor Transmission of Materials
ASTM E 514	1986)Test for Water Permeance of Masonry

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Materials; FIO.

Manufacturer's descriptive data including catalog cuts and Material Safety Data Sheets (MSDS). Descriptive data shall include complete technical characteristics, curing and drying times, and detailed mixing, thinning, and application instructions.

SD-13 Certificates

Volatile Organic Compound (VOC) Content; FIO

Certificate stating that the water repellent materials proposed for uses conforms to the VOC restrictions of the local Air Pollution Control District.

SD-14 Samples

Materials; FIO.

One liter sample of sample of water repellant sealer specified herein. The sample containers shall include the same information on the label as

specified herein for containers delivered to the job.

SD-18 Records

Qualifications of the Applicator;FIO

Certification attesting that the applicator is approved by the manufacturer of the water repellent sealer shall be submitted to the Contracting Officer prior to commencement of the work of this section.

1.3 PACKAGING, LABELING, AND STORING

Sealers shall be in sealed containers that legibly show the designated name, quantity, data of manufacture, manufacturer's directions, including any warnings and special precautions, and name of manufacturer. Containers shall be stored in accordance with the manufacturer's written directions and as a minimum stored off ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors at temperatures between 4.44 and 37 degrees C. Containers of sealer shall be kept from freezing at all times.

1.4 WARRANTY

The manufacturer of the water repellent sealer shall guarantee that work under this section shall be free of defects in materials and workmanship for a period of 5 years from the date of final acceptance. Warranty shall provide for reapplication of the sealer system if water penetration occurs during the warranty period as a result of defective materials or workmanship from this section of work.

1.5 ENVIRONMENTAL CONDITIONS

Surface, air, and material temperature shall be 7.2 degrees C or higher during application. Do not apply water repellent sealer when temperatures are expected to fall below 7.2 degrees C within 12 hours, or if rain is expected to fall within 4 hours of application. Sealer shall be applied only to surfaces that are completely free of surface moisture as determined by sight or touch. In no case shall sealer be applied when there is visible frost or ice.

PART 2 PRODUCTS

2.1 GENERAL

Water repellent sealer shall be a clear, water repellent solution designed to protect vertical concrete masonry surfaces from water penetration. All exterior concrete masonry unit wall surfaces of the facility shall be treated with water repellent sealer unless otherwise specified.

2.1.1 Volatile Organic Compound (VOC) Content

Water repellent sealers shall comply with the applicable state and local laws enacted to insure compliance with Federal Clean Air Standards. Material shall conform to the restrictions of the local Air Pollution Control District.

2.2 WATER REPELLENT SEALER

Sealer shall be a water-based, non-film forming, silane penetrating sealer. No silicone, mercuric, chromate, or lead compounds shall be permitted. Sealer shall conform to the following minimum technical characteristics:

a. Solids and Active Ingredients by Weight.....Approx. 12%
b. Flash Point (ASTM D 3278).....Above 38 Degrees C
c. Penetration Depth.....1.5 mm-9mm
d. Volatile Organic Compound (VOC).....250 g/1 maximum
e. Water Repellence Tests (ASTM C 67).....96% (minimum)
f. Water Permeance Test of Masonry (ASTM E 514:
   Percentage Reduction of Leakage on CMU wall...99.8% minimum
g. Moisture Vapor Transmission Rate (ASTM E 96)..82% minimum
h. Accelerated Weathering (QUV) Testing
   2,500 hours.....No loss in repellency
i. Yellowing.....None
j. Efflorescence.....Highly resistant
k. Drying Time for Recoat (if necessary).....2-4 hours
l. Surface Appearance After Application.....Slight darkening

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE TREATED

Surfaces not to be treated which are in contact with or adjacent to wall surfaces that are to receive water repellent treatment shall be removed or protected prior to surface preparation and sealing operations. Items removed prior to sealer application shall be replaced when application is completed. Surfaces contaminated by water repellent sealer materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to receive water repellent sealer shall be prepared in accordance with the manufacturer's written instructions and the following requirement. Surfaces to be sealed must be thoroughly dry, clean, and free from oil, grease, tar, dirt, alkali, efflorescence, or other contaminants. Any apparent alkali or efflorescence shall be treated with a neutralizing compound as recommended by the concrete block supplier. Loose or disintegrating mortar joints shall be repointed and allowed 72 hours drying time before application. Caulking and sealant work must be done prior to the application and allowed 612 hours curing time before application is begun.

3.3 APPLICATION

Water repellent sealer shall only be applied by an applicator approved by the manufacturer, in strict accordance with the manufacturer's printed instructions. Surfaces that have been cleaned, pretreated, and otherwise prepared for sealing shall be sealed as soon as practical after such pretreatment has been completed, but before any deterioration of the prepared surfaces. At the time of application, sealer shall show no signs of deterioration. The final appearance shall be free of film, runs, drops, ridges, waves, or other surface flaws.

3.3.1 Manufacturer's Representative

An authorized representative of the manufacturer shall be notified a minimum of 48 hours in advance of the start of the application of the water repellent treatment, and shall be present during the initial application of the sealer, in order to meet warranty requirements. The manufacturer's representative and a representative of the Contracting Officer shall approve surface preparation prior to application of the water repellent treatment sealer.

3.3.2 Samples

A sample of the water repellent sealer shall be applied to the masonry sample panel as required by Section 04200: Masonry. When the sample panel has sufficiently dried, the approved applicator shall, in the presence of a representative of the Contracting Officer, take a 1-liter or larger sealed, sample container and thoroughly mix and apply the sealer to the sample panel in accordance with the manufacturer's instruction. The approved sample panel will be used for quality control of the application of the water repellent sealer to the rest of the building.

3.3.3 Coverage

Surfaces to be sealed shall be flooded with a minimum 4-inch rundown onto surfaces to assure maximum saturation into the substrate. Coverage shall be complete, and done so that the required penetration occurs uniformly over the wall surfaces. Special attention shall be given to insure that all edges, corners, and crevices receive an equivalent application to that of adjacent sealed surfaces shall be in accordance with the manufacturer's recommendations.

3.4 CLEANING

Cloths and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site. Adjacent surfaces contaminated with sealer shall be properly cleaned and left in their original condition.

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SECTION 07220

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SECTION 07220

ROOF INSULATION

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 A208.1	(1993) Particleboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 726	(1993) Mineral Fiber Roof Insulation Board
ASTM C 728	(1991) Perlite Thermal Insulation Board
ASTM C 984	(1994) Perlite Board and Rigid Cellular Polyurethane Composite Roof Insulation
ASTM C 1050	(1991) Rigid Cellular Polystyrene - Cellulosic Fiber Composite Roof Insulation
ASTM C 1289	(1995) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 312	(1995) Asphalt Used in Roofing
ASTM D 2178	(1989) Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM D 4897	(1994) Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM F 547	(1977; R 1990) Terminology of Nails for

Use with Wood and Wood-Base Materials

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825 (1995; Supple 1; Supple II; Supple III) Approval Guide

UNDERWRITERS LABORATORIES (UL)

UL-01 (1996) Building Materials Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Application of Insulation; FIO].

Insulation manufacturer's recommendations for the application and installation of insulation.

SD-08 Statements

Inspection; FIO.

The inspection procedure for insulation installation, prior to start of roof insulation work.

SD-13 Certificates

Insulation; FIO. Organic Roofing Felt; FIO.

Certificate attesting that the expanded perlite or polyisocyanurate insulation contains recovered material and showing estimated percent of recovered material. Certificates of compliance for felt materials.

1.3 STORAGE OF MATERIALS

Extruded polystyrene shall be stored in accordance with manufacturer's instructions. Other 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 10 degrees C 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-01 or Class I in FM P7825.

PART 2 PRODUCTS

2.1 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, and the thickness. Minimum thickness shall be as recommended by the manufacturer. Boards shall be marked individually. The insulation manufacturing process shall not include chlorofluoro carbons (CFC) or formaldehydes. Insulation and fiberboard shall contain the highest practicable percentage of material which has been recovered or diverted from solid waste (e.g., postconsumer waste), but not including material reused in a manufacturing process. Where two materials have comparable price and performance, the one having the higher recovered material content shall be selected. Insulation shall be one, or a combination of the following materials:

2.1.1 Mineral-Fiber Insulation Board

ASTM C 726.

2.1.2 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.

2.2 NAILS AND FASTENERS

Nails and fasteners shall conform to the following requirements:

2.2.1 Fasteners

Insulation manufacturer's recommendations except holding power, when driven, shall be not less than 178 N each in steel deck. Fasteners for steel or concrete decks shall conform to FM P7825 for Class I roof deck construction, and shall be spaced to withstand an uplift pressure of 2.87 kPa.

2.2.2 Metal Disks

Flat and not less than 0.39 mm thickness. Disks used with nails or fasteners for securing fiberboard insulation shall be minimum 25 mm diameter. Disks used with nails or fasteners for securing other board insulation shall be minimum 53 mm in diameter.

2.3 ORGANIC ROOFING FELT

ASTM D 226, Type I.

2.4 WOOD NAILERS

Wood nailers shall conform to Section 06100 ROUGH CARPENTRY including preservative treatment. Edge nailers shall be not less than nominal 150 mm wide and of thickness to finish flush with the top surface of the insulation. Surface mounted nailers shall be a nominal 75 mm 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 waterproofed when more than one day is required to finish the roofing. Phased construction will not be permitted.

3.2 ENVIRONMENTAL CONDITIONS

Air temperature shall be above 4 Degrees C and there shall be no visible ice, frost, or moisture on the roof deck when the insulation and roofing are installed.

3.3 SUBSTRATE PREPARATION

The substrate construction of any bay or section of the building shall be completed before insulation or vapor retarder 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 100 mm 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 INSTALLATION OF WOOD NAILERS

Nailers shall be secured to cast-in-place deck materials by not less than 9 mm diameter anchors embedded in the deck not over 1.2 meters on centers. Nailers shall be secured to precast deck materials and 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 1.2 meters face-to-face, except that where the insulation units are less than 1.2 meters in length the nailers shall be spaced to minimize cutting of the insulation.

3.5 APPLICATION OF INSULATION

Insulation shall be laid in one layer. 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 6 mm. 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.

3.5.1 Mechanical Fastening

On steel decks, or any slope exceeding 42 mm/m, the insulation shall be mechanically fastened. Method of attachment shall be in accordance with recommendations of the insulation manufacturer and requirements specified.

3.5.2 Steel Decks

Uninsulated steel decks shall have insulation applied to span the steel deck flutes and to act as an underlayment for the roof membrane. I

nsulation on steel deck shall be compatible with mechanical fastening.

3.5.3 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.

3.6 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 P7825.

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.

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SECTION 07240

EXTERIOR INSULATION AND FINISH SYSTEM

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 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 67	(1994) Sampling and Testing Brick and Structural Clay Tile
ASTM C 473	(1995) Physical Testing of Gypsum Board Products and Gypsum Lath
ASTM C 578	(1992) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 920	(1987) Elastomeric Joint Sealants
ASTM C 947	(1989) Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 948	(1994) Dry and Wet Bulk Density, Water Absorption and Apparent Porosity of Thin Sections of Glass-Fiber-Reinforced Concrete
ASTM C 1149	(1990) Self-Supported Spray-Applied Cellulosic Thermal or Acoustical Insulation, or Both
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 2394	(1983; R 1993) Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM E 72	(1980) Conducting Strength Tests of Panels for Building Construction
ASTM E 84	(1995) Surface Burning Characteristics of Building Materials
ASTM E 96	(1994) Water Vapor Transmission of Materials

ASTM E 136	(1994) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM G 23	(1995) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1993) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) For Exposure of Nonmetallic Materials

EIFS INDUSTRY MEMBERS ASSOCIATION (EIMA)

EIMA 101.86	(1992; Rev May 1994) Resistance of Exterior Insulation and Finish Systems to the Effects of Rapid Deformation (Impact)

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-102S94	(1994) Uniform Building Code Standards: Uniform Building Code, Vol. III

1.2 DESCRIPTION

The exterior insulation and finish system (EIFS) shall be a job-fabricated exterior wall covering consisting of insulation, reinforcing fabric, base coat, finish coat, and accessories. The system shall be the standard product of a manufacturer regularly engaged in furnishing exterior insulation and finish systems and shall be installed by an applicator approved by the system manufacturer. EIFS shall be cementitious, Class PM and shall be havecolor and finish as indicated.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Test Specimens

Unless otherwise noted, the test specimens shall consist of reinforcement, base coat and finish coat applied in accordance with the manufacturer's printed recommendations to an insulation board common to the system. These test specimens shall be suitably sized for the apparatus used and be allowed to cure for a minimum of 28 days prior to testing.

1.3.1.1 Flame Spread

Flame spread test samples consist of base coat, fabric and finish coat, mounted on a non-combustible substrate. When tested in accordance with ASTM E 84, the samples shall have a flame spread rating of 25 or less.

1.3.1.2 Full Scale Wall Fire Test

Full scale wall fire test specimens shall include the complete system with no less than 100 mm of insulation. Test shall be performed in accordance with ICBO-102S94, Section 17-6. The specimen shall not contribute to significant or horizontal flame spread.

1.3.2 Impact Test

The exterior insulation and finish system shall have been tested in accordance with EIMA 101.86 using a specimen consisting of cured finish system over 25 mm thick insulation with base coat and reinforcing fabric in a complete assembly typical of the project application. Specimen shall withstand an impact of 6-10 newton-meters.

1.3.3 Structural Performance Test

The system shall have been tested in accordance with ASTM E 330 to minimum positive and negative pressures of 891 Pa. Test panels shall be 1.2 m by 1.2 m minimum, consisting of the typical system assembly.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Exterior Insulation and Finish System; FIO.

Two copies of manufacturer's standard printed instructions for installation of the system. Instructions shall include manufacturer's recommended details for corner treatment, jambs, sills, openings, joints and other special applications.

SD-09 Reports

Exterior Insulation and Finish System; FIO.

Test Reports indicating that the system complies with the specified performance tests. Tests shall be by an approved, independent testing laboratory.

SD-14 Samples

Exterior Insulation and Finish System; GA.

Two samples of each exterior insulation and finish system. Each sample shall be 300 mm square, minimum, and shall be identical to the proposed installation in thickness, color, texture, insulation and workmanship.

SD-08 Statements

Manufacturer's Approval and License; FIO.

Statement from manufacturer attesting that the applicator is approved and licensed to install the system.

1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand name, and description of contents. Storage shall be in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area.

Stored materials shall be protected from sunlight, and kept away from excessive heat. Coating materials which would be damaged by freezing shall be kept at a temperature not less than 4 degrees C. Insulation board shall not be exposed to flame or other ignition sources.

PART 2 PRODUCTS

2.1 EXTERIOR CEMENT BOARD

Exterior cement board shall be a non-combustible exterior grade portland cement product. Board shall be 1220 by 2440 mm with a minimum 16 mm thickness. Boards shall consist of an aggregated portland cement core faced on both surfaces and wrapped on long edges with an embedded polymer-coated glass fiber mesh. Bonding surface shall have rough texture. Exterior cement board shall comply with the following requirements:

Property	Test Method	Requirement
Flexural Strength	ASTM C 947	5 MPa, Min.
Compressive Strength	ASTM D 2394	8.6 MPa, Min.
Crack Resistance	ASTM E 72	No cracking
Non-combustibility	ASTM E 136	Pass
Flame Spread/Smoke	ASTM E 84	5/0 max.
Water Absorption	ASTM C 948	15 percent max.
Fastener Pull Resistance	ASTM C 473	534 N (wet or dry)

2.2 ADHESIVE

Adhesive shall be the manufacturer's standard product, including primer as required, and shall be compatible with the substrate to which the system is applied.

2.3 INSULATION

Insulation shall conform to ASTM C 578, type as recommended by the system manufacturer and shall be compatible with other system components. Insulation shall be aged a minimum of 6 weeks by air drying, or equivalent prior to installation. 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, and thickness. Thickness of insulation shall not be less than 19 mm thick. Boards shall be marked individually.

2.4 BASE COAT

Base coat shall be the manufacturer's standard product and shall be compatible with the finish coat.

2.5 REINFORCING FABRIC

Reinforcing fabric shall be balanced, open weave, glass fiber fabric made

from twisted multi-end strands specifically treated for compatibility with the other materials of the system.

2.6 MECHANICAL ANCHORS

Mechanical anchors shall be as recommended by the system manufacturer.

2.7 FINISH COATING

Finish coating shall be manufacturer's standard product, uniform in color and conforming to the following requirements. Specimens for tests shall have been cured for a minimum of 28 days.

TEST	METHOD	RESULTS
Abrasion Resistance	ASTM D 968	500 liters of sand-slight - smoothing no loss of film integrity.
Accelerated weathering Light and water exposure	ASTM G 23 or ASTM G 53	2000 hours. No deterioration
Mildew-fungus resistance	ASTM C 1149	Expose for 28 days at 95 percent RH, 32 degrees C temperature. No growth of mildew or fungus.
Salt spray resistance	ASTM B 117	Withstand 300 hours - No deleterious effects.
Water vapor	ASTM E 96	Not more than 13 grams per square meter an hour.
Absorption-freeze (Pre-weighed 100 mm by 200 mm specimens; 25 mm insulation, faced with finish coat cured and stored in air; tested with edges and back open.)	ASTM C 67 50 Cycles: 20 hrs. at -9 degrees C; 4-hr. thaw in water	After 50 cycles - Total weight gain of not more than 6.2 grams. No checking, splitting, or cracking.

2.8 SEALANT

Sealant shall meet requirements of ASTM C 920, Class 25, and shall be compatible with the finish system. Type, Grade, and Use shall be as recommended by both the sealant manufacturer and the system manufacturer. When required, primer, bond breaker and backstop shall be non-staining, and as recommended by the sealant manufacturer and the system manufacturer.

2.9 ACCESSORIES

Accessories shall conform to the recommendations of the system manufacturer and shall include trim, edging, anchors, sealant and filler rod required for proper installation of the system. Continuous soffit vent shall be pre-manufactured and shall be rigid PVC with free air flow of 31,742 sq mm per lineal meter (15 square inches per lineal foot) continuous. Soffit vent shall conform to ASTM E 84.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surface shall be free of oil, loose materials or protrusions which will interfere with the system installation.

3.2 ENVIRONMENTAL CONDITION

Unless a higher temperature is required by the system manufacturer, the ambient air temperature shall be 4 degrees C or greater and rising at the time of installation of the system and shall be predicted to remain at 4 degrees C or greater for at least 24 hours after installation.

3.3 EXTERIOR CEMENT BOARD

Exterior cement board shall be attached to metal studs with self-tapping wafer-head, corrosion resistant screws, nailed to wood studs, or secured to concrete or masonry with approved fasteners. Screws and nails for application of the board shall be spaced not more than 200 mm on each supporting member, and fasteners into concrete or masonry shall be spaced not more than 300 mm apart horizontally and vertically. Fasteners shall be more closely spaced when required for negative wind load resistance. Edges and ends of boards shall be butted snugly with vertical joints staggered to provide full and even support for the insulation.

3.4 INSULATION BOARD AND REINFORCING FABRIC

Unless otherwise specified by the system manufacturer, insulation boards shall be placed horizontally from a level base line. Vertical joints shall be staggered and insulation boards interlocked at corners. Joints of insulation shall be butted tightly. Surfaces of adjacent insulation boards shall be flush at joints. Joints of insulation shall be offset from substrate joints. Reinforcing glass fabric shall be installed in accordance with the manufacturer's instructions.

3.5 ADHESIVE SYSTEM

Primer (if required by the manufacturer) and adhesive shall be prepared and applied with a stainless steel trowel to substrate in accordance with the manufacturer's instructions. The pattern of the reinforcing fabric shall not be visible. Adhesive used with Class PM must be supplemented with mechanical fasteners. Adhesive shall be used without fasteners only with Class PB system and when recommended by the manufacturer.

3.6 BASE COAT

Base coat shall be mixed in accordance with the manufacturer's instructions and applied to insulated wall surfaces, trowelling the material into the reinforcing fabric in a tight coat and doubling back to provide complete coverage of the reinforcing fabric, panel joints and fasteners. Base coat may be used to level out surface areas when permitted by the manufacturer.

3.7 FINISH COATING

Finish coating shall be applied and leveled in one operation. Final texture shall be obtained by trowels, floats, or by spray application as necessary to achieve the required finish. Finish surfaces shall be plane,

with no deviation greater than 6 mm when tested with a 3 m straightedge.

3.8 SEALANT

Edges of the exterior insulation and finish system shall be sealed at openings as recommended by the system manufacturer.

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SECTION 07320

CONCRETE TILE ROOFING

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.

FEDERAL SPECIFICATIOINS (FS)

FS HH-I-1972/GEN	(&Am-1) Insulation board, Thermal, Faced, Polyurethane or Polyisocyanurate

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM C 518	(1985) Steady-State heat Flux Measurements and Thermal Tr5ansmission Properties by Means of the Heat Flow Meter Apperatus
ASTM C 270	(1984) Mortar for Unit Masonry
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 2822	(1991) Asphalt Roof Cement

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA-02	(1996) NRCA Roofing and Waterproofing Manual

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Concrete Tile Roof System; GA.

Manufacturer's catalog data and installation instructions.

SD-04 Drawings

Concrete Tile Roof System; GA.

Drawings showing clay tile installation and appearance details, flashing details, and fastening details for the tiles.

SD-08 Statements

Qualifications; FIO.

Documentation showing qualifications of personnel proposed to perform the roofing work, and a listing identifying prior installations completed by the Contractor.

SD-13 Certificates

Certificates of Compliance; FIO.

Certificates of compliance attesting that the materials meet specification requirements.

SD-14 Samples

Concrete Roofing Tiles; GA.

One representative tile of each type.

Sealants; FIO.

237 mL of each type.

Underlayment Sheet; FIO.

300 by 300 mm section of each type.

Fasteners; FIO.

Representative samples of each fastener with identifying tags.

1.3 QUALIFICATIONS

The Contractor shall provide qualified workers, trained and experienced in installing concrete tile roofing systems of this configuration, and shall submit documentation of 5 consecutive years of work of this type. The Contractor shall be familiar with and shall perform work in accordance with SMACNA-02. A list of installations shall be provided which identifies when, where, and for whom the installations were made.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in manufacturer's unopened bundles and containers with the manufacturer's brand and name marked clearly thereon.

Tiles shall be stored in accordance with manufacturer's printed instructions. Roll goods shall be stored on end in an upright position. Immediately before laying, roofing felt shall be stored for 24 hours in an area maintained at a temperature not lower than 10 degrees C.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

Concrete tile roofing work shall proceed when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

1.5.2 Material Storage

Materials shall not be stored on roof decks in such a manner as to overstress and/or damage the deck and supporting structure. Placing of loads at midspans of framing shall be avoided. Superimposed loads shall be well distributed.

1.5.3 Units of Work

Units of work shall be established, including removal of existing materials, preparation of existing surfaces and application of underlayment and nailers, and related temporary and/or permanent flashing so that it can be completed prior to the end of each working day.

1.5.4 Temporary Protection Materials

Materials shall be provided and maintained on the site at all times for temporary roofing, flashing, and other protection when delays and/or changed weather conditions do not permit completion of each unit of work prior to the end of each working day. Materials which have been used for temporary roofing, flashing and other protection shall be removed and discarded.

1.6 WARRANTY

A warranty shall be furnished against defects in material and workmanship of concrete tile roof assembly, including related metal flashing for a period of 10 years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Concrete Roofing Tile

Molded concrete interlocking roof tile units of shapes and configuration indicated, with integral color, free from imperfections. Include specially shaped, color-matched units as indicated or required for eaves, rakes, ridges, hips, valleys and other conditions. Provide with fastening holes predrilled at time of manufacture. Interlocking concrete units shall be approximately 314 mm by 432 mm and weigh approximately 43.5 kg per square meter. Tile shall not exceed 58.6 kg per square meter.

2.1.1.1 Colors

Concrete tile color shall be as indicated.

2.1.2 Membrane

An underlayment membrane shall be furnished on surfaces to be covered with tile. Membrane shall consist of asphalt-saturated felt.

2.1.2.1 Roofing Felt

Roofing felt shall be asphalt-saturated rag felt, Type II, No. 30 asphalt felt in accordance with ASTM D 226.

2.1.3 Fasteners

2.1.3.1
Concrete roof tile shall be fastened to 25 gauge galvanized steel battens with wire ties and stainless steel screws.

2.1.3.2 Miscellaneous Fasteners

Miscellaneous fasteners may include but are not limited to: wind locks, hurricane clips, tile attachment brackets, tile nails, twisted wire (tile-tie), deck anchor systems, and flashing cleats. Fasteners shall be made of solid stainless steel.

2.1.4 Flashing

Flashing shall be 0.57 kg , light cold-rolled temper stainless steel conforming to ASTM A 167 . Like metals shall be used on all components of fastening systems and flashing in order to avoid galvanic action. Flashing shall be in accordance with the requirements as specified in Section 07600 SHEET METALWORK, GENERAL.

2.1.5 Plastic Cement

Plastic cement for gable rakes, hip rolls, ridges, stringers and other conditions shall be non-running, heavy body plastic cement composed of ingredients complying with ASTM D 2822.

2.1.6 Sealant

Sealant, when used in lieu of plastic cement, shall be silicone in accordance with ASTM C 1184.

2.1.7 Mortar

Mortar for filling the openings of cut valley tiles shall consist of 1 part portland cement to 3 parts damp plaster sand, and shall be colored to the nearest possible match with the color of the tile.

2.1.8 Wood Strips

Wood strips for nailers, cant strips, and eave strips shall be of foundation grade redwood or preservative treated Douglas fir. Sizes and lengths shall be provided per tile manufacturer's installation details.

2.1.9 Hold Down Clips

Hold down clips shall consist of the manufacturer's standard metal corrosion resistant clips and shall be provided per the tile manufacturer's

installation details along all eaves and field tiles.

2.2 SUBSTRATE PANELS (FOR APPLICATION OVER STRUCTURAL METAL DECK)

2.2.1 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 24 degrees C in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation , including facings, shall have a flame spread not in excess of 25 and a smoke developed rating not in excess of 50 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

2.2.2 Rigid Board Insulation for Use Above Roof Deck

2.2.2.1 Polyisocyanurate

Polyisocyanurate insulation shall conform to ASTM C 1289, Type I, Class 2 (having a minimum recovered material content of 9 percent by weight of core material).

2.2.3 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

PART 3 EXECUTION

3.1 PROTECTION OF ROOF SURFACES

Equipment (such as padded ridge ladders) and techniques shall be used which prevent damage to roof as a result of foot or material traffic. Contractor shall be responsible for controlling breakage of new or existing tile beyond what is indicated. The progression of work shall be laid out and presented to the Contracting Officer to prevent other trades from working on or above completed roofing. Personnel who are working on the roof shall have proper shoes which will not further damage tiles and shoe soles shall be made of a material which will aid in preventing falls.

3.2 PREPARATION OF SURFACES

Roof deck surfaces shall be smooth, clean, firm, dry, and free from loose boards, large cracks, and projecting ends that might damage the roofing. Foreign particles shall be cleaned from all interlocking areas to ensure proper seating and to prevent water damming. Prior to installation of tile, vents and other projections through roofs shall be properly flashed and secured in position, and projecting nails shall be driven firmly home.

3.3 ROOFING FELT UNDERLAYMENT

3.3.1 Standard Application

Felt shall be laid in horizontal layers on deck areas to be covered with tile. Two layers of No. 30 felt shall be applied. Applications shall be doubled on rough surfaces and overlapped 300 mm on hips, valleys, and ridges. Joints shall be lapped 63 mm horizontally and 150 mm vertically. Felt shall be carried 150 mm up vertical surfaces and 100 mm over gutter and valley metal. Edges shall be fastened with corrosion-resistant, 12 gauge, 9.5 mm head standard roofing nails on 150 mm centers. Felt shall be preserved unbroken, tight and whole.

3.4 METAL FLASHING

Metal flashing shall be as shown at intersections of vertical or projecting surfaces through the roof or against which the roof abuts, such as walls, parapets, and dormers. Flashing installation shall be in accordance with Section 07600 SHEET METALWORK, GENERAL.

3.5 INSULATION INSTALLATION

Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

3.5.1 Board Insulation

Rigid board insulation shall be laid in close contact. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. Install type30 felt commencing at the eave and overlapping fascia board 1 inch laid parallel to eave. Complete installation of field underlayment/membrane, shingle fashion maintaining 2 inch head and 6 inch side laps. Secure underlayment with 12 inch centers at all laps and 30 inch on center down the logitudinal center line of each ply. Interface of all plies at valley sections crossing for full coverage. The underlayment membrane must weatherproof the roof deck. It must be a weatherproof barrier capable of shedding moisture to which it may be exposed, allowing it to escape at the eave.

3.5 CONCRETE ROOFING TILE (GENERAL)

3.5.1 Roof Decks and Fasteners

Tile shall be fastened to roof deck materials as follows:

DECK	FASTENER
Metal	Sheet metal screw and mastic
Fibrous cement	Tile-tie system

Note: All fastening and flashing metals shall be of like material in order to avoid galvanic action.

3.5.2 Chalk Lines

Horizontal and vertical guide lines shall be chalked on the membrane to assure proper appearance. The chalk lines shall be spaced by measuring the delivered tiles for average length and width exposures. An exposure length

of 6 mm beyond the average shall not be exceeded.

3.6 ONE-PIECE BARREL TRIM TILE APPLICATION

3.6.1 Wood Strips

Wood stringers, 25 mm wide and of proper height, shall be applied on hips and ridges to carry hip roll and ridge. A 25 by 50 mm strip shall be applied for end bands. A 25 by 50 mm cant strip shall be applied at eaves if eave closures are not specified.

3.6.2 Tile Application

a. Eave closures shall be installed first.

b. Tiles shall be laid to straight lines parallel to ground level and shall be lapped 75 mm vertically.

c. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

d. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

e. Gable rakes shall be cemented to field tiles and fastened with nails.

f. Hip rolls shall be cemented in laps and fastened with 50 mm copper nails.

g. Ridges shall be cemented and fastened with 63 mm copper nails in laps and where they rest on roof tiles.

h. Where tiles join hip stringers they shall be made waterproof with flashing cement.

i. When hip starter and closed ridge end fittings have not been specified, the voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

j. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

k. When ridge angles and hip/ridge terminals are not otherwise specified, they shall be mitered on job, nailed or wired, and set in plastic cement.

l. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm adjustment of regular tile overhang at eave is sufficient.

3.7 INTERLOCKING S TILE APPLICATION

3.7.1 Wood Strips

Wood stringers, 25 mm wide and of proper height, shall be applied on hips

and ridges to carry hip roll and ridge. A 22 by 25 mm cant strip shall be applied at eaves.

3.7.2 Tile Application

a. Tiles shall be laid to straight lines parallel to ground level, lapped 75 mm vertically.

b. Each tile shall be fastened with 1, 2, or 3 nails as required in each tile or fitting. Nails shall not be driven so far as to produce a strain on the tile, nor left proud to stress overlapping tile.

c. Nails on tiles overlapping sheet metalwork shall not puncture the sheet metal. Tiles overlapping sheet metal shall be fastened with copper wire and plastic cement.

d. Gable rakes shall be cemented to field tiles and fastened with nails.

e. Hip rolls shall be cemented and fastened with 50 mm copper nails in laps.

f. Ridges shall be cemented and fastened with 63 mm copper nails in laps and where they rest on roof tiles.

g. Where tiles join hip stringers they shall be made waterproof with flashing cement.

h. Voids at ends of hips and ridges shall be filled with mortar colored to nearest match of tile color.

i. Tile in contact with cement mortar shall be immersed in water for at least 2 minutes before laying.

j. Ridge angles and hip/ridge terminals shall be mitered on job, nailed or wired, and set in plastic cement.

k. When short course tiles are not otherwise specified for rafters which do not accommodate full courses, they shall be cut and drilled on job by roofer unless a plus or minus 25 mm adjustment of regular tile overhang at eave is sufficient.

3.7.3 Hold Down Clips

Hold down clips shall be screwed to the metal battens or the metal deck through the underlayment with the manufacturer's recommended screws. Attachment pattern shall be per manufacturer's recommendation, but shall not be less than one clip per tile.

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SECTION 07600

SHEET METALWORK, GENERAL

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
ASTM B 32	(1995b) Solder Metal
ASTM B 209	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 543	(1987) Resistance of Plastics to Chemical Reagents
ASTM D 822	(1995) Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus
ASTM D 828	(1993) Tensile Breaking Strength of Paper and Paperboard
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2822	(1991) Asphalt Roof Cement
ASTM D 3656	(1994) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing

ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM E 96	(1995) Water Vapor Transmission of Materials

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual

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.

1.2.1 Coordination

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. Application of bituminous strip flashing over various sheet metal items is covered in Section 07510 BUILT-UP ROOFING. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in othersections.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Materials; FIO.

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-02 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-02. 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 07920 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 Polyvinyl Chloride (PVC) Reglets

ASTM D 1784, Class 14333D, 1.9 mm minimum thickness.

2.1.8 Aluminum Alloy Sheet and Plate

ASTM B 209, form, alloy, and temper appropriate for use.

2.1.9 Copper

ASTM B 370, Temper H 00.

2.1.10 Stainless Steel

ASTM A 167, Type 302 or 304; fully annealed, dead soft temper.

2.1.11 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.12 Through-Wall Flashing

a. Electro-sheet copper not less than 0.14 kg, factory coated both sides with acid- and alkali-resistant bituminous compound not less than 1.8 kg per square meter or factory covered both sides with asphalt-saturated cotton fabric, asphalt saturated glass-fiber fabric, or with 18 kg reinforced kraft paper bonded with asphalt.

b. Stainless steel, Type 304, not less than 0.08 mm thick, completely encased by and permanently bonded on both sides to 23 kg high strength bituminized crepe kraft paper, using hot asphalt, heat, and pressure.

c. Nonreinforced, waterproof, impermeable extruded elastomeric single ply sheeting not less than 0.76 mm thick.

d. 0.09 kg copper sheet, with 0.05 mm of dense, clear, polyethylene sheet bonded to each side of the copper.

e. Other through-wall flashing material may be used provided the following performance criteria are met.

(1) No cracking or flaking when bent 180 degrees over a 0.8 mm mandrel and rebent at the same point over the same mandrel in an opposite direction at 0 degree C.

(2) Water vapor permeability not more than 115 ng per Paper second per square meter (2 perms) when tested in accordance with ASTM E 96.

(3) Minimum breaking strength of 24 kgf/15 mm width in the weakest direction when tested in accordance with ASTM D 828.

(4) No visible deterioration after being subjected to a 400-hour direct weathering test in accordance with ASTM D 822.

(5) No shrinkage in length or width and less than 5 percent loss of breaking strength after a 10-day immersion, per ASTM D 543, in 5 percent (by weight) solutions, respectively, of sulfuric acid, hydrochloric acid, sodium hydroxide or saturated lime (calcium hydroxide).

2.1.13 Louver Screen

Type III aluminum alloy insect screening conforming to ISWA IWS 089.

PART 3 EXECUTION

3.1 GENERAL

Items such as gutters, downspouts and louvers shall be fabricated in conformance with SMACNA-02 and as indicated. Unless otherwise specified or indicated, exposed edges shall be folded back to form a 13 mm hem on the concealed side, and bottom edges of exposed vertical surfaces shall be angled to form drips. Bituminous cement shall not be placed in contact with roofing membranes other than built-up roofing.

3.2 EXPANSION JOINTS

Expansion joints shall be provided as specified in SMACNA-02. Expansion

joints in continuous sheet metal shall be provided at 12.0 meter intervals for copper and stainless steel and at 9.6 meter intervals for aluminum, except extruded aluminum gravel stops and fasciae which shall have expansion joints at not more than 3.6 meter spacing. Joints shall be evenly spaced. An additional joint shall be provided where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing.

3.3 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:

3.3.1 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.

3.3.2 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.

3.4 CONNECTIONS AND JOINTING

3.4.1 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.

3.4.2 Riveting

Joints in aluminum sheets 1.0 mm or less in thickness shall be mechanically made.

3.4.3 Seaming

Flat-lock and soldered-lap seams shall finish not less than 25 mm wide. Unsoldered plain-lap seams shall lap not less than 75 mm unless otherwise specified. Flat seams shall be made in the direction of the flow.

3.5 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 3 mm apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 300 mm 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.

3.6 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be installed as indicated. Gutters shall be supported by continuous cleats or by cleats spaced not less than 915 mm apart. Downspouts shall be rigidly attached to the building. Supports for downspouts shall be spaced according to manufacturer's recommendations. Leaders shall connect gutters on overhanging eaves to dwonspouts. Leaders shall be set with a slope not less thatn .52% or more than 30 degrees below a horizontal line. Leaders shall fit over the outlet tube in gutter bottom and shall fit into and be riveted to the downspouts. Rivet spacing shall be not more than 51mm. Strainers shall be set loosely in the eave tube opening in gutter. Joints between lengths of downspouts shall be made by telescoping the end of the upper length at least 19mm into the lower length. Downspouts terminating in downspout boots shall be provided with adaptors to fit inside the downspout boot.

3.7 FLASHINGS

Flashings shall be installed at locations indicated and as specified below. Sealing shall be according to the flashing manufacturer's recommendations. Flashings shall be installed at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls are specified in other sections. Except as otherwise indicated, counter flashings shall be provided over base flashings. Perforations in flashings made by masonry anchors shall be covered up by an application of bituminous plastic cement at the perforation. Flashing shall be installed on top of joint reinforcement. Flashing shall be formed to direct water to the outside of the system.

3.7.1 Base Flashing

Metal base flashing shall be coordinated with roofing work. Metal base flashing shall be set in plastic bituminous cement over the roofing membrane, nailed to nailing strip, and secured in place on the roof side with nails spaced not more than 75 mm on centers. Metal base flashing shall not be used on built-up roofing.

3.7.2 Counter Flashings

Except as otherwise indicated, counter flashings shall be provided over base flashings. Counter flashing shall be installed as shown in SMACNA-02. Where bituminous base flashings are provided, the counter flashing shall extend down as close as practicable to the top of the cant strip. Counter flashing shall be factory formed to provide spring action against the base flashing.

3.7.3 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

3.7.4 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.

3.7.4.1 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 100 mm beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

3.7.5 Valley Flashing

Valley flashing shall be installed as specified in SMACNA-02 and as indicated.

3.8 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.

3.9 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.

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SECTION 07900

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SECTION 07900

JOINT SEALING

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 570	(1995) Oil- and Resin-Base Caulking Compound for Building Construction
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM C 1085	(1991) Butyl Rubber-Based Solvent-Release Sealants
ASTM C 1184	(1995) Structural Silicone-Sealants
ASTM D 217	(1994) Cone Penetration of Lubricating Grease
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1565	(1981; R 1990) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Backing; FIO. Bond-Breaker; FIO.

Sealant; FIO.

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-13 Certificates

Sealant; FIO.

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 4 to 32 degrees C 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 4 and 32 degrees C 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 2, closed cell, Class A, Grade 1, round cross section.

2.1.2 PVC

Polyvinyl chloride (PVC) backing shall be ASTM D 1565, Grade VO 12, open-cell foam, round cross section.

2.1.3 Synthetic Rubber

Synthetic rubber backing shall be ASTM C 509, Option I, Type I preformed rods or tubes.

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 LATEX

Latex Sealant shall be ASTM C 834.

2.4.2 ELASTOMERIC

Elastomeric sealants shall conform to ASTM C 920 and the following:

a. Polysulfide Sealant: Type S or M, Grade NS or P, Class 25, Use NT, G, A, or O.

b. Polyurethane sealant: Grade NS or P, Class 25 , Use NT, G, A, or O.

c. Silicone sealant: Type S or M, Grade NS or P, Class 25, Use NT, G, A, or O.

2.4.3 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.

2.4.4 BUTYL

Butyl sealant shall be ASTM C 1085.

2.4.5 PREFORMED

Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 34 to plus 71 degrees C, the sealant shall be non-bleeding and shall have no loss of adhesion.

2.4.5.1 Foam Strip

Foam strip shall be polyurethane foam. Foam strip shall be capable of sealing out moisture, air, and dust when installed and compressed as recommended by the manufacturer. Service temperature shall be minus 40 to plus 135 degrees C. Untreated strips shall be furnished with adhesive to hold them in place. Adhesive shall not stain or bleed into adjacent finishes. Treated strips shall be saturated with butylene waterproofing or impregnated with asphalt.

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 may 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.

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SECTION 08110

STEEL DOORS AND FRAMES

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 236	(1989; R 1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 976	(1990) Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
ASTM D 2863	(1991) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E 90	(1990) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1G	(1994) Installation Guide for Doors and Hardware

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM HMMA 862	(1987) Hollow Metal Manual; Section: Guide Specifications for Commercial Security Hollow Metal Doors and Frames
NAAMM HMMA 865	(1995) Hollow Metal Manual; Section: Guide Specifications for Swinging Sound Control Hollow Metal Doors and Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	X (1995) Fire Doors and Windows
NFPA 80A	(1993) Protection of Buildings from Exterior Fire Exposures

NFPA 101	X (1997) Safety to Life from Fire in Buildings and Structures
NFPA 252	(1995) Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames
SDOI SDI-106	(1996) Standard Door Type Nomenclature
SDOI SDI-107	(1984) Hardware on Steel Doors (Reinforcement - Application)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Doors and Frames; FIO.

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, and weatherstripping including air infiltration data and manufacturers printed instructions.

SD-13 Certificates

Sound Rated Doors; FIO.

a. Certification of Oversized Fire Doors: Certificates of compliance in accordance with the requirements of NFPA 252 for fire doors exceeding the sizes for which label service is available.

b. Certification of Sound Rating: Certification or test report for sound rated doors shall show compliance with the specified requirements. The certification, or test report, shall list the parameters and the type of hardware and perimeter seals used to achieve the rating.

SD-14 Samples

Steel Doors and Frames; FIO.

Manufacturer's standard color samples of factory applied finishes.

1.3 DELIVERY AND STORAGE

During shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or shall be provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be

securely strapped in bundles. Materials shall be delivered to the site in undamaged condition, and stored out of contact with the ground and under a weathertight covering permitting air circulation. Doors and assembled frames shall be stored in an upright position in accordance with DHI A115.1G. 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 1 year period shall be provided.

PART 2 PRODUCTS

2.1 DOORS AND FRAMES

Doors and frames shall be factory fabricated in accordance with SDOI SDI-100 and the additional requirements specified herein. Door grade shall be heavy duty (Grade II) unless otherwise indicated on the door and door frame schedules. Exterior doors and frames shall be designation A40 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. Doors and frames shall be reinforced for surface applied hardware. Frames shall be welded type located as shown. Door frames shall be furnished with a minimum of three jamb anchors and one floor anchor per jamb. Anchors shall be not less than 1.2 mm steel or 4.5 mm diameter wire. 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; adhesively applied silencers are not acceptable. Where frames are installed in plaster or masonry walls, plaster guards shall be provided on door frames at hinges and strikes. Full glass doors shall conform to SDOI SDI-100, Model 3, and shall include provisions for glazing. Reinforcing of door assemblies for closers and other required hardware shall be in accordance with SDOI SDI-100and the conditions of the fire door assembly listing when applicable. Exterior doors shall have top edges closed flush and sealed against water penetration.

2.2 SOUND RATED DOORS

Sound rated doors and frames shall be factory fabricated in accordance with NAAMM HMMA 865 and shall be provided at locations shown on the drawings. Door assemblies shall consist of 1.2 mm minimum thickness door, 1.7 mm minimum thickness frame, and adjustable perimeter seals. The Sound Transmission Class rating of the assembly shall be 45 or as shown on the drawings when tested in accordance with ASTM E 90.

2.3 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 0.31 l/s per linear meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.4 LOUVERS

Where indicated, doors shall be provided with full louvers or louver sections. Louvers shall be sightproof type inserted into the door. Pierced louvers shall not be used on exterior doors. Inserted louvers shall be stationary. Louvers shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors. Insect screens shall be a removable type with 18 by 16 mesh aluminum or bronze cloth. Full louver doors shall be in accordance with SDOI SDI-100, Grade III, Model 3.

2.5 FACTORY FINISH

Doors and frames shall be phosphatized, primed, and finished with an electrostatic baked on enamel or polyester base factory finish paint . Color shall be as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with DHI A115.1G. Preparation for surface applied hardware shall be in accordance with SDOI SDI-107. Rubber silencers shall be installed in door frames after finish painting has been completed; adhesively applied silencers are not acceptable. Weatherstripping shall be installed at exterior door openings to provide a weathertight installation. Hollow metal door frames shall be solid grouted in masonry walls.

3.1.1 Sound Rated Doors

Sound rated doors shall be installed in accordance with the manufacturer's printed instructions. Hardware and perimeter seals shall be adjusted for proper operation.

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.

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SECTION 08120

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SECTION 08120

ALUMINUM DOORS AND FRAMES

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	(1980; R 1993) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605.2	(1992; Addenda Jan 1995) Voluntary Specification for High Performance Organic Coatings on Architectural Aluminum Extrusions and Panels
AAMA 1503.1	(1988) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 331	(1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

1.2 SYSTEM DESCRIPTION

Swing-type aluminum doors and frames, of size and design shown on the drawings, shall be provided at the locations indicated. Doors shall be furnished complete with frames, subframes, trim, and other accessories indicated and specified.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Wind Load Performance

Doors and frames shall be of sufficient strength to withstand a design wind load of 1440] Pa of supported area with a deflection of not more than 1/175 times the length of the member. Doors shall be tested in accordance with ASTM E 330 at a pressure not less than 1.5 times the design load.

1.3.2 Water Penetration Performance

Frames and fixed areas, and non-handicap complying doors shall have no water penetration when tested in accordance with ASTM E 331 at a pressure of 383 Pa .

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data
Aluminum Doors and Frames; FIO.

Manufacturer's descriptive data and catalog cuts including air-infiltration data.

SD-04 Drawings

Aluminum Doors and Frames; FIO.

A schedule showing the location of each door shall be included with the drawings. Drawings showing elevations of each door and frame type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, and details of joints and connections.

SD-06 Instructions

Installation; FIO. Cleaning; FIO.

Manufacturer's installation instructions and cleaning instructions.

SD-09 Reports

Full-Glazeds; FIO.

For full-glazed and flush doors, certified test reports from an independent testing laboratory, stating that doors are identical in design, materials, and construction to a door that has been tested and meets all test and specified requirements.

SD-14 Samples

Finishes; FIO.

Samples of the color anodized coating, showing the extreme color range.

1.5 DELIVERY AND STORAGE

Materials delivered to the jobsite shall be inspected for damage, and shall be unloaded with a minimum of handling. Storage shall be in a dry location with adequate ventilation, free from dust, water, and other contaminants, and which permits easy access for inspecting and handling. Materials shall be neatly stored on the floor, properly stacked on nonabsorptive strips or wood platforms. Doors and frames shall not be covered with tarps, polyethylene film, or similar coverings.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

PART 2 PRODUCTS

2.1 ALUMINUM DOORS AND FRAMES

Extrusions shall comply with ASTM B 221, Alloy 6063-T5 except alloy used for anodized color coatings shall be required to produce the specified color. Aluminum sheets and strips shall comply with ASTM B 209, alloy and temper best suited for the purpose. Fasteners shall be hard aluminum or stainless steel.

2.1.1 Finishes

Finish shall be color anodized. Color anodized finish shall be AA-M10C22A32 in accordance with the requirements of AA DAF-45. Color shall be as indicated.

2.1.2 Welding and Fastening

Where possible, welds shall be located on unexposed surfaces. Welds required on exposed surfaces shall be smoothly dressed. Welding shall produce a uniform texture and color in the finished work, free of flux and spatter. Exposed screws or bolts will be permitted only at inconspicuous locations and shall have heads countersunk.

2.1.3 Anchors

Anchors shall be stainless steel or steel with a hot-dipped galvanized finish. Anchors of the sizes and shapes required shall be provided for securing aluminum frames to adjacent construction. Anchors shall be placed near top and bottom of each jamb and at intermediate points not more than 625 mm apart. Transom bars shall be anchored at ends, and mullions shall be anchored at head and sill. Where indicated on the drawings, vertical mullion reinforcement shall be of sufficient length to extend up to the overhead structural slab or framing and be securely attached thereto. The bottom of each frame shall be anchored to the rough floor construction with 2.4 mm thick stainless steel angle clips secured to the back of each jamb and to floor construction. Stainless steel bolts and expansion rivets shall be used for fastening clip anchors. Freestanding door frames shall be reinforced and securely anchored to floor construction.

2.1.4 Provisions For Hardware

Hardware for aluminum doors is specified in Section 08700 BUILDERS'

HARDWARE. Doors and frames shall be cut, reinforced, drilled, and tapped at the factory to receive template hardware. Reinforcement shall be provided in the core of doors as required to receive locks, door closers, and other hardware. Doors to receive surface applied hardware shall be reinforced as required.

2.1.5 Provisions For Glazing

Glazing shall be as specified in Section 08810 GLASS AND GLAZING. Metal glazing beads, vinyl inserts, and glazing gaskets shall be provided for securing glass. Glass stops shall be tamperproof on exterior side.

2.1.6 Weatherstripping

Weatherstripping shall be continuous silicone-treated wool pile type, or a type recommended by the door manufacturer, and shall be provided on head and jamb of exterior doors. Weatherstripping for bottom of doors shall be as shown. Weatherstripping shall be easily replaced without special tools, and shall be adjustable at meeting stiles of pairs of doors. Air leakage rate of weatherstripping shall not exceed 0.775 L/s per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.2 FABRICATION OF ALUMINUM FRAMES

Frames shall be double-glazed and shall have a minimum total average unit thermal resistance of 0.34 square meter degree K per W. 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 of equivalent design may be submitted, subject to approval of samples. Minimum metal wall thickness shall be 2.29 mm, except glazing beads, moldings, and trim shall be not less than 1.27 mm. Frames that are to receive glass shall have removable snap-on glass stops and glazing beads. Joints in frame members shall be milled to a hairline watertight fit, reinforced, and secured mechanically by steel clip arrangement or by screw spline attachment.

2.3 FABRICATION OF ALUMINUM DOORS

2.3.1 Sizes, Clearances, and Edge Treatment

Doors shall be not less than 44.4 mm thick. Clearances shall be 1.6 mm at hinge stiles, 3 mm at lock stiles and top rails, and 5 mm at floors and thresholds. Single-acting doors shall be beveled 3 mm at lock and meeting stile edges. Double-acting doors shall have rounded edges at hinge stile, lock stile, and meeting stile edges.

2.3.1.1 Full-Glazed Stile and Rail Doors

Doors shall have medium stiles and rails as shown, and shall be fabricated from extruded aluminum hollow seamless tubes or from a combination of open-shaped members interlocked or welded together. Doors shall be double-glazed and shall have a minimum total average unit thermal resistance of 0.34 square meter degree K per W. Top and bottom rail shall be fastened together by means of welding or by 10 mm diameter cadmium-plated tensioned steel tie rods. An adjustable mechanism shall be provided in the top rail of narrow stile doors to allow for minor clearance adjustments after installation. Extruded aluminum snap-in glazing beads shall be provided on interior side of doors. Extruded aluminum theft-proof

snap-in glazing beads or fixed glazing beads shall be provided on exterior or security side of doors. Glazing beads shall have vinyl insert glazing gaskets, designed to receive glass of thickness required. Glass is specified in Section 08810 GLASS AND GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION OF DOORS, FRAMES, AND ACCESSORIES

3.1.1 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.

3.1.1.1 Paint

Aluminum surfaces to be protected shall be solvent cleaned and given a coat of zinc-molybdate primer and one coat of aluminum paint.

3.1.1.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and shall be cemented to the aluminum surface using a cement compatible with aluminum.

3.1.2 Installation

Frames and framing members shall be accurately set in position to receive doors. Frames shall be plumb, square, level, and in alignment, and securely anchored to adjacent construction. Metal-to-metal joints between framing members shall be sealed as specified in Section 07920 JOINT SEALING. Doors shall be accurately hung with proper clearances, and adjusted to operate properly. Protective coverings if provided shall be removed and the doors and frames shall be thoroughly cleaned.

-- End of Section --

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SECTION 08353

ACCORDION PARTITIONS, FOLDING DOORS, AND OPERABLE PARTITIONS

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SECTION 08353

ACCORDION PARTITIONS, FOLDING DOORS, AND OPERABLE PARTITIONS

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	(1995a) Surface Burning Characteristics of Building Materials
ASTM E 90	(1990) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
ASTM E 413	(1987; R 1994) Rating Sound Insulation
ASTM F 793	(1993) Standard Classification of Wallcovering by Durability Characteristics

CODE OF FEDERAL REGULATIONS (CFR)

FEDERAL STANDARDS (FED-STD)

FED-STD 795	(Basic) Uniform Federal Accessibility Standards

UNDERWRITERS LABORATORIES (UL)

UL 10B	(1993) Fire Tests of Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Accordion Partitions; GA.

Manufacturer's descriptive data, performance charts, catalog cuts, and installation instructions.

SD-04 Drawings

Accordion Partitions; GA.

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-13 Certificates

Materials; FIO. Accordion Partitions; FIO.

Certificate attesting that the materials meet the requirements specified and that partitions have specified acoustical and flame retardant properties, as determined by test.

SD-14 Samples

Accordion Partitions; GA

Manufacturer's standard color samples of specified surfaces and finishes.

SD-19 Operation and Maintenance Manuals

Accordion Partitions; FIO. .

Six complete copies of operating instructions outlining the procedures required for electrically operated partitions. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and operating features. 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 year and 3 years of service.

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. The instructions shall include equipment layout and simplified wiring and control diagrams of the system as installed.

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 latch only. An upper latch with extended pulls shall be provided on units over 2400 mm . Hardware shall be anodized aluminum with a natural finish, chrome plated or brass plated metal, 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 1800 mm 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 Metal Soffit

Soffit shall be provided when steel track is recessed. Soffit 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. Soffit on aluminum track shall be an integral part of the track.

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. Doors shall be manually operated. Door widths shall be as shown.

2.2.1 Pantograph Framework with Flexible Covering

Accordion partitions shall have a steel pantograph hinged framework and shall have a sound liner and shall meet the STC rating of 44 in accordance with ASTM E 90 and ASTM E 413]. Intermediate pantographs shall be provided as required and door shall have a control device to prevent flattening of the folds when the panel is fully extended. The covering shall be vinyl coated fabric.

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.

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SECTION 08520

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SECTION 08520

ALUMINUM WINDOWS

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	(1980) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(1993) Voluntary Specifications for Aluminum and Poly(Vinyl Chloride) (PVC) Prime Windows and Glass Doors
AAMA 603.8	(1992) Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum
AAMA 605.2	(1992; Addenda Feb 1994) Voluntary Specification for High Performance Organic Coatings on Architectural Aluminum Extrusions and Panels
AAMA 1503.1	(1988) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM E 547	(1993) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A39.1	(1991; A39.1a) Safety Requirements for Window Cleaning

INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089	(1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(1994) Safety to Life from Fire in Buildings and Structures

SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA 1004	(1987) Aluminum Tubular Frame Screens for Windows

1.2 WINDOW PERFORMANCE

Aluminum windows shall be designed to meet the following performance requirements. Testing requirements shall be performed by an independent testing laboratory or agency.

1.2.1 Structural Performance

Structural test pressures on window units shall be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There shall be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by AAMA 101for each window type when tested in accordance with ASTM E 283.

1.2.3 Water Penetration

Water penetration shall not exceed the amount established by AAMA 101for each window type when tested in accordance with ASTM E 547.

1.2.4 Thermal Performance

Thermal transmittance for thermally broken aluminum windows with insulating glass shall not exceed R-Value Class 0.59 m/W when tested in accordance with AAMA 1503.1.

1.2.5 Life Safety Criteria

Windows shall conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Aluminum Windows; FIO.

Manufacturer's descriptive data and catalog cut sheets.

SD-04 Drawings

Aluminum Windows; FIO.

Drawings indicating elevations of window, rough-opening dimensions for each type and size of window, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, and window schedules showing locations of each window type.

SD-06 Instructions

Aluminum Windows; FIO.

Manufacturer's preprinted installation instructions and cleaning instructions.

SD-09 Reports

Aluminum Windows; FIO.

Reports for each type of aluminum window attesting that identical windows have been tested and meet all performance requirements established under paragraph WINDOW PERFORMANCE.

SD-13 Certificates

Aluminum Windows; FIO.

Certificates stating that the aluminum windows are AAMA certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

SD-14 Samples

Aluminum Windows; FIO.

Manufacturer's standard color samples of the specified finishes.

1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of aluminum windows specified in this section, and shall have a minimum of 4] years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.5 DELIVERY AND STORAGE

Aluminum windows shall be delivered to project site and stored in

accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

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 ALUMINUM WINDOW TYPES

Aluminum windows shall consist of complete units including sash, glass, frame, weatherstripping, insulating panels, and hardware. Windows shall conform to AAMA 101. Windows shall be double-glazed and shall have a minimum condensation resistance factor of 48 when tested in accordance with AAMA 1503.1. Operable windows shall permit cleaning the outside glass from inside the building.

2.1.1 Fixed Windows

Aluminum fixed windows shall conform to AAMA 101 F-C40 type, non-operable glazed frame, complete with provisions for reglazing in the field.

2.2 WEATHERSTRIPPING

Weatherstripping for ventilating sections shall be of type designed to meet water penetration and air infiltration requirements specified in this section in accordance with AAMA 101, and shall be manufactured of material compatible with aluminum and resistant to weather. Weatherstrips shall be factory-applied and easily replaced in the field. Neoprene or polyvinylchloride weatherstripping are not acceptable where exposed to direct sunlight.

2.3 ACCESSORIES

2.3.1 Fasteners

Fastening devices shall be window manufacturer's standard design made from aluminum, non-magnetic stainless steel, cadmium-plated steel, nickel/chrome-plated steel or magnetic stainless steel in compliance with AAMA 101. Self-tapping sheet metal screws will not be acceptable for material thicker than 2 mm.

2.3.2 Hardware

Hardware shall be as specified for each window type and shall be fabricated of aluminum, stainless steel, cadmium-plated steel, zinc-plated steel or nickel/chrome-plated steel of quality established by AAMA 101.

2.3.3 Window Anchors

Anchoring devices for installing windows shall be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA 101.

2.4 GLASS AND GLAZING

Aluminum windows shall be designed for inside glazing, field glazing, and

for glass types scheduled on drawings and specified in Section 08810GLASS AND GLAZING. Units shall be complete with glass and glazing provisions to meet AAMA 101. Glazing material shall be compatible with aluminum, and shall not require painting.

2.5 FINISH

2.5.1 Anodized Aluminum Finish

Exposed surfaces of aluminum windows shall be finished with anodic coating conforming to AA DAF-45: Architectural Class I, AA-M10-C22-A44, color anodic coating, 0.02 mm or thicker. Finish shall be free of scratches and other blemishes.

2.5.2 Color

Color shall be as indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Aluminum windows shall be installed in accordance with approved shop drawings and manufacturer's published instructions. Aluminum surfaces in contact with masonry, concrete, wood and dissimilar metals other than stainless steel, zinc, cadmium or small areas of white bronze, shall be protected from direct contact using protective materials recommended by AAMA 101. The completed window installation shall be watertight in accordance with Section 07920 JOINT SEALING. Glass and glazing shall be installed in accordance with requirements of this section and Section 08810 GLASS AND GLAZING.

3.2 ADJUSTMENTS AND CLEANING

3.2.1 Hardware Adjustments

Final operating adjustments shall be made after glazing work is complete. Operating sash or ventilators shall operate smoothly and shall be weathertight when in locked position.

3.2.2 Cleaning

Aluminum window finish and glass shall be cleaned on exterior and interior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring window finish and glass surfaces.

-- End of Section --

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SECTION 08700

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SECTION 08700

BUILDERS' HARDWARE

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 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA-01	(Effective thru Jun 1995) Directory of Certified Locks & Latches
BHMA-02	(Effective thru Jul 1995) Directory of Certified Door Closers
BHMA-03	(Effective thru Jul 1996) Directory of Certified Exit Devices
BHMA ANSI/BHMA A156.1	(1988) Butts and Hinges
BHMA ANSI/BHMA A156.3	(1994) Exit Devices
BHMA ANSI/BHMA A156.4	(1992) Door Controls - Closers
BHMA ANSI/BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA ANSI/BHMA A156.6	(1994) Architectural Door Trim
BHMA ANSI/BHMA A156.7	(1988) Template Hinge Dimensions
BHMA ANSI/BHMA A156.13	(1994) Mortise Locks & Latches
BHMA ANSI/BHMA A156.16	(1989) Auxiliary Hardware

BHMA ANSI/BHMA A156.18	(1993) Materials and Finishes
BHMA ANSI/BHMA A156.21	(1989) Thresholds
BHMA ANSI/BHMA A156.23	(1992) Electromagnetic Locks

DOOR AND HARDWARE INSTITUTE (DHI)

DHI-03	(1989) Keying Systems and Nomenclature
DHI-04	(1976) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames
DHI-05	(1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames
DHI-A115.IG	(1994) Installation Guide for Doors and Hardware
DHI A115-W	(Varies) Wood Door Hardware Standards (Incl All5-W1 thru A115-W9)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) Fire Doors and Windows
NFPA 101	(1997) Safety to Life from Fire in Buildings and Structures
NFPA 105	(1993) Installation of Smoke-Control Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hardware and Accessories; FIO.

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices, after approval of the detail drawings, and not later than 1 month 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-04 Drawings

Hardware Devices; GA.

Detail drawings for hardware devices for computerized keying systems, magnetic cards, keyless push button access control systems, and other electrical hardware devices showing complete wiring and schematic diagrams and other details required to demonstrate proper function of units.

SD-07 Schedules

Hardware Schedule; FIO.

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; corresponding reference standard type number or function number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

Keying Schedule; GA.

Keying schedule developed in accordance with DHI-03, after the keying meeting with the user.

SD-13 Certificates

Hardware and Accessories; FIO.

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA-01, BHMA-02 and BHMA-03 directories of certified products may be submitted in lieu of certificates.

1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

1.4 DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

1.5 SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 OPERATION AND MAINTENANCE MANUALS

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. The instructions for electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices shall include simplified diagrams as installed.

PART 2 PRODUCTS

2.1 GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein and the HARDWARE SETS listing at the end of this section. Hardware set numbers correspond to the set numbers shown on the drawings.

2.2 TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA ANSI/BHMA A156.7.

2.3 HINGES

Hinges shall conform to BHMA ANSI/BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA ANSI/BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations.

2.3.1 Hinges for Reverse Bevel Doors with Locks

Hinges for reverse bevel doors with locks shall have pins that are made nonremovable by means such as a set screw in the barrel, or safety stud, when the door is in the closed position.

2.3.2 Contractor's Option

Hinges with antifriction bearings may be furnished in lieu of ball bearing hinges, except where prohibited for fire doors by the requirements of NFPA 80.

2.3.3 Pivot Hinges

Pivot hinges shall conform to BHMA ANSI/BHMA A156.4.

2.4 LOCKS AND LATCHES

To the maximum extent possible, locksets, latchsets and deadlocks shall be the products of a single manufacturer. Lock fronts for double-acting doors shall be rounded. Strikes for wood frames and pairs of wood doors shall be furnished with wrought boxes.

2.4.1 Mortise Lock and Latchsets

Mortise lock, latchsets, and strikes shall be series 1000 and shall conform to BHMA ANSI/BHMA A156.13, operational Grade 1. Strikes for security doors shall be rectangular without curved lip. Mortise type locks and latches for doors 44 mm thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts. Locksets and latchsets shall be compatible with "Schlage", 6 pins and non-interchangeable cores.

2.4.2 Electronic Locks

Electronic locks shall allow for unlocking by card reader and/or keypad (See SECTION 16752 and Electrical Drawings for additional information). Locks shall be fail safe mode (unlocked when power is off). Locks shall be mortise series conforming to BHMA ANSI/BHMA A156.13 with factory installed electric lock modification or manufactured electronic locks conforming to BHMA ANSI/BHMA A156.13 or BHMA ANSI/BHMA A156.2 test standards. For additional information regarding Electronic Locks see **SECTION 16752, ELECTRONIC ENTRY CONTROL SYSTEM.**

2.4.3 Auxiliary Locks and Associated Products

Mortise dead locks and dead latches, narrow style dead locks and dead latches, rim latches, dead latches, and dead bolts, and electric strikes shall conform to BHMA ANSI/BHMA A156.5. Bolt and latch retraction shall be dead bolt style. Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1. Electric strikes shall be locked or unlocked from a remote location. Electric strike for rated openings shall be fail secured.

2.3.4.7 Combination Locks (With Dials and Rings)

The door shall have a changeable combination lock which shall control the door locking mechanism. The lock shall meet the requirements of FF-L-2740. The lock shall be key change. The lock design or installation shall not compromise the integrity of the door. The lock's dial ring shall be mounted so as to be flush to the surface of the door. The attachment of the dial ring shall be firm and secure without movement or side play. The lock case shall be firmly and securely attached to the door by suitable and effective means so that there is no movement or side play to the lock case. The lock shall not be modified in any manner from the formation supplied by the lock manufacturer, except that the spindle may be cut to proper length.
Key change combination locks. Key change combination locks shall be designed to be readily combination changeable by use of a key or special tool.
Combination change shall not require removal or disassembly of the lock. Changing procedures shall require the lock to have the bolt extended during changing and shall ensure the operator must know the current operating combination prior to changing the combination. 3.4.3 Bolt lockout. The lock shall have a mechanical relock device that will block the bolt in the locked position if the lock cover plate is moved more than 0.10 inch (2.54 mm) at any point from its normal operating position. The lock combination shall be input by dialing. The combination for opening the lock shall not exceed four

numbers. Each number shall be within the range of 0 and 99, inclusive. The lock shall have as a minimum 1,000,000 operational combinations as defined in 6.3.
The dial, spindle, bolt and all internal parts shall operate smoothly for the operating life of the lock, without the addition of anything but proper lubricants and without showing appreciable wear. Lock bolt operation. All energy required for lock bolt operation shall be derived from mechanical operation of the lock dial by the operator. Once the lock bolt has been extended to the locked position, it shall not be possible to reopen the lock without completely redialing the lock combination. For purposes of this requirement, the locked position means the bolt has been fully extended.

2.4.4 Lock Cylinders (Mortise and Rim)

Lock cylinders shall comply with BHMA ANSI/BHMA A156.5. Lock cylinder shall have not less than six pins. Cylinders shall have key removable type cores. An extension of the existing keying system shall be provided. The cylinders shall be compatible with existing locks that were manufactured by SCHLAGE , have non-interchangeable cores. Construction interchangeable cores shall be provided. Disassembly of lever handle or lockset shall not be required to remove core from lockset. All locksets and lockable exit devices shall accept same interchangeable cores.

2.4.5 Lock Trim

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA ANSI/BHMA A156.2 or BHMA ANSI/BHMA A156.13 lever handles, roses, and escutcheons shall be 1.27 mm thick, if unreinforced. If reinforced, the outer shell shall be 0.89 mm thick and the combined thickness shall be 1.78 mm except that lever handle shanks shall be 1.52 mm thick. Lever handles shall be of plain design with ends returned to no more than 10 mm from the door face.

2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA ANSI/BHMA A156.3, Grade 1.

2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices. Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. [Touch bars [may] [shall] be provided in lieu of conventional crossbars and arms.] [Escutcheons shall be provided not less than 175 by 55 mm. Escutcheons shall be cut to suit cylinders and operating trim.]

2.5.2 Automatic Flush Bolts

Automatic flush bolts shall be Type 25 in accordance with BHMA ANSI/BHMA A156.3, and shall be installed at the top and bottom of the inactive leaf of pairs of fire rated doors where specified in the hardware sets. Flush bolts shall be mortised in the strike edge of the door.

2.6 KEYING

Locks shall be keyed in sets or subsets as scheduled. Locks shall be furnished with the manufacturer's standard construction key system. Change keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

Locks: 2 change keys each lock.

The keys shall be furnished to the Contracting Officer arranged [in a container] [for key control system storage] in sets or subsets as scheduled.

2.7 DOOR CLOSING DEVICES

Door closing devices shall conform to BHMA ANSI/BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 67 N applied at the latch stile or exceed 22 N where low opening resistance is scheduled.

2.7.1 Surface Type Closers

Surface type closers shall be Grade 1, Series C02000 Full Cover with options PT-4H, Size 1 or 2 through Size 6, and PT-4D with back check position valve. Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position.

2.7.2 ARCHITECTURAL DOOR TRIM

Architectural door trim shall conform to BHMA ANSI/BHMA A156.6.

2.7.2.1 Door Protection Plates

2.8 Kick Plates

Kick plates shall be Type J102 stainless steel. Width of plates shall be 50 mm less than door width for single doors and 25 mm less for pairs of doors. Height shall be [250] [300] [400] mm, except where the bottom rail is less than [250] [300] [400] mm the plate shall extend to within 13 mm of the panel mold or glass bead. Edges of metal plates shall be beveled.

2.9 Door Edge Guards

Door edge guards shall be furnished to protect door edges with the required cut-outs for hardware items such as hinges, flush bolts, and locks. Door edge guards shall satisfy fire door ratings. Door edge guards shall be Type j210 1.27 mm thick stainless steel.

2.10 Door Pulls

Door pulls shall be Category J400 stainless steel of plain modern design.

2.11 AUXILIARY HARDWARE

Auxiliary hardware, consisting of door holders,door stops, shall conform to BHMA ANSI/BHMA A156.16. Lever extension flush bolts shall be Type L14081. Dust-proof strikes shall be Type L04011 for doors that are not fire rated.

Dust-proof strikes shall be Type L04021 for fire rated doors. 2.11.1 MISCELLANEOUS

2.11.1.1 Automatic Door Bottoms

Automatic door bottoms shall be recessed type with aluminum housing cover, anodized clear finish. Door bottom shall have a wool, felt, rubber, vinyl, or neoprene seal and shall be actuated by the opening and closing of the door. The door bottom shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

A set of acoustical seals shall include adjustable doorstops at head and jambs and an automatic door bottom, both of extruded aluminum, clear anodized, surface applied, with vinyl fin seals between plunger and housing. Doorstops shall have solid neoprene tube, silicone rubber, or closed-cell sponge gasket. Door bottoms shall have adjustable operating rod and silicone rubber or closed-cell sponge neoprene gasket. Doorstops shall be mitered at corners.

2.11.1.2 Metal Thresholds

Thresholds shall conform to BHMA ANSI/BHMA A156.21. Thresholds for exterior doors shall be bronze of the type indicated and shall provide proper clearance and an effective seal with specified weather stripping. Latching thresholds shall conform to BHMA ANSI/BHMA A156.3, Type 26, and of such height that the bottom of the door shall be 3 mm over the tread of the threshold and 3 mm below the top of the stop. Where required, thresholds shall be modified to receive projecting bolts of flush bolts or exit devices
. Thresholds for doors accessible to the handicapped shall be beveled with slopes not exceeding 1:2 and with heights not exceeding 13 mm. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.11.1.3.1 Aluminum Housed Type Weatherseals

Weatherseals of the type indicated shall consist of extruded aluminum retainers not less than 1.78 mm wall thickness with vinyl, neoprene, silicone rubber, polyurethane or vinyl brush inserts. Aluminum shall be bronze anodized. Weatherseal material shall be of an industrial/commercial grade. Seals shall remain functional through all weather and temperature conditions. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

2.12 Key Control Storage System

Key control storage system shall conform to BHMA ANSI/BHMA A156.5, and shall be properly labeled for key identification. Set up, identification labeling and location of the key control storage shall be as directed at the Predelivery Conference. Capacity of key control storage system shall be coordinated with Contracting Officer.

2.13 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields

shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

2.14 FINISHES

Unless otherwise specified, finishes shall conform to those identified in BHMA ANSI/BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL.

2.15 HARDWARE FOR FIRE DOORS

Hardware for fire doors shall conform to the requirements of NFPA 80and NFPA 101.

PART 3 EXECUTION

3.1 APPLICATION

Hardware shall be located in accordance with DHI-04 and DHI-05, except that deadlocks shall be mounted 1220 mm above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI-A115.IG or DHI A115-W. Door control devices for exterior doors such as closers and holders, shall be attached to doors with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses. Electric hardware items and access control devices shall be installed in accordance with manufacturer's printed installation procedures.

3.1.1 Hardware for Fire Doors and Smoke-Control Door Assemblies

Hardware for fire doors shall be installed in accordance with the requirements of NFPA 80. Exit devices installed on fire doors shall have a visible label bearing the marking "Fire Exit Hardware". Other hardware installed on fire doors, such as locksets, closers, and hinges shall have a visible label or stamp indicating that the hardware items have been approved by an approved testing agency for installation on fire-rated doors. Hardware for smoke-control door assemblies shall be installed in accordance with NFPA 105.

3.1.2 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

3.1.3 Key Control Storage Systems

Key control storage system shall be furnished to the Contracting Officer.

3.1.4 Kick Plates

Kick plates shall be installed on the push side of single-acting doors and on both sides of double-acting doors.

3.1.5 Auxiliary Hardware

Lever extension flush bolts shall be installed at the top and bottom of the inactive leaf of pairs of doors. The bottom bolt shall operate into a dust-proof floor strike or threshold.

3.1.6 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 300 mm. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 19 mm thread engagement into the floor or anchoring device used.

3.1.7 Rain Drips

Door sill rain drips shall align with the bottom edge of the door. Overhead rain drips shall align with bottom edge of door frame rabbet. Drips shall be set in sealant and fastened with stainless steel screws.

3.1.8 Weatherseals

Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

3.2 OPERATIONAL TESTS

Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are operating as intended by the specifications. Wiring shall be tested for correct voltage, current carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

3.3 HARDWARE SETS

FINISH	FINISH DESCRIPTION / BASE METAL
600	**PRIMED FOR PAINTING / STEEL**
630	**SATIN STAINLESS STEEL**
647	**SATIN NICKEL PLATED / STEEL**

HW-1

1 EA.	**ELECTRONIC ENTRY CONTROL SYSTEM** (SECTION 167520	630
6 EA.	PIVOT HINGES, A5711 (PAINT TO MATCH DOOR)	630
2 EA.	CLOSERS, C02021 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
2 EA.	EXIT DEVICES, TYPE 05, FUNCTION 02	647
2 EA.	DOOR PULLS, J401	630
2 EA.	DOOR SWEEP SEALS	600
1 EA.	METAL THRESHOLD, J32100	MED. BRONZE
2 EA.	DOOR STOPS, L02131	647

HW-2

6 EA.	PIVOT HINGES, A5711 (PAINT TO MATCH DOOR)	630
2 EA.	CLOSERS, C02021 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
2 EA.	EXIT DEVICES, TYPE 05, FUNCTION 02	630
2 EA.	CYLINDERS, E09211	630
2 EA.	DOOR PULLS, J401	630
2 EA.	DOOR SWEEP SEALS	630
1 EA.	METAL THRESHOLD, J32100	MEDIUM BRONZE
2 EA.	DOOR STOPS, L02131	630

HW-3

3 EA.	HINGES, A5111	630
1 EA.	CLOSER, C02011 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
1 EA.	METAL THRESHOLD, J32100	MED. BRONZE
1 EA.	DOOR STOP, L02131	630

HW-4

1 EA.	**ELECTRONIC ENTRY CONTROL SYSTEM** (SECTION 16752)	630
3 EA.	PIVOT HINGES, A5711 (PAINT TO MATCH DOOR)	630
1 EA.	CLOSERS, C02021 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	EXIT DEVICES, TYPE 05, FUNCTION 02	630
1 EA.	DOOR PULLS, J401	630
1 EA.	DOOR SWEEP SEALS	MED. BRONZE
1 EA.	METAL THRESHOLD, J32100	MED. BRONZE
1 EA.	DOOR STOPS, L02131	630

HW-5

3 EA.	HINGES, A5111	630
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
1 EA.	DOOR STOPS, L02131	630

NOTE:
PROVIDE THE FOLLOWING IN LIEU OF AT DOOR NUMBERS 113, 128, 215

1 EA.	**LOCKSET, F15**	**630**

PROVIDE THE FOLLOWING AT DOOR NUMBERS 114, 117, 121, 141, 144

1 EA.	**AUTOMATIC DOOR BOTTOM** PLUS DOOR ACOUSTICAL SEALS	**630**

HW-6

3 EA.	HINGES, A5111	630
1 EA.	CLOSER, C02011 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
1 EA.	DOOR STOP, L02131	630

HW-7

6 EA.	HINGES, A8111	647
2 EA.	CLOSER, C02011 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
2 EA.	LEVER EXTENSION BOLTS, L04181 (AT INACTIVE DOOR)	630
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
1 EA.	METAL THRESHOLD,J33100	MED. BRONZE

HW-8

1 EA. ELECTRONIC ENTRY
CONTROL SYSTEM 630
(SECTION 16752)
1 EA. COMBINATION LOCK 630
3 EA. HINGES, A8111 630
1 EA. CLOSER, C02011 600
(PAINT TO MATCH
ADJACENT DOOR FRAME)
1 EA. DOOR STOP, L02131 630
1 EA. DOOR SWEEP
NOTE: Combination Lock shall be equivalent to Hamilton X07 (MAS)

HW-9

1 EA. ELECTRONIC ENTRY
CONTROL SYSTEM 630
(SECTION 16752)
3 EA. HINGES, A5111 630
1 EA. CLOSER, C02011 600
(PAINT TO MATCH
ADJACENT DOOR FRAME)
1 EA. DOOR STOP, L02131 630

PROVIDE:
1 EA. METAL THRESHOLD, J32100 MED. BRONZE

AT DOOR NUMBERS 165,166,167,172,186,187,188,194,
206,207,208,213,216,221,222,223,228 ONLY.
PLEASE VERIFY LOCATIONS OF METAL THRESHOLDS
(SEE DRAWINGS)

NOTE:
PROVIDE THE FOLLOWING AT DOOR NUMBERS 166, 187, 207,
214, 215, 222

1 EA. LOCKSET, F15 630

PROVIDE THE FOLLOWING AT DOOR NUMBERS 160, 166, 172, 173,
174, 175, 176, 177,178, 179, 180, 181, 186, 188, 193, 201, 206,
208, 213, 216, 221, 223, 228

1 EA. AUTOMATIC DOOR BOTTOM 630
PLUS DOOR ACOUSTICAL SEALS

HW-10

3 EA.	HINGES, A8111	630
1 EA.	CLOSER, C02011 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	LATCHSET, F01 (W/LEVER HANDLES)	630
2 EA.	KICKPLATES, J102 (MOUNT AT CORRIDOR SIDE OF TOILET ROOM DOORS)	630
1 EA.	DOOR STOP, L02131	630

HW-11

3 EA.	HINGES, A5111	630
1 EA.	CLOSER, C02011 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	LATCHSET, F01 (W/LEVER HANDLES)	630
1 EA.	DOOR STOP, L02131	630

HW-12

6 EA.	HINGES, A5111	630
2 EA.	CLOSER, C02021 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
2 EA.	LEVER EXTENSION BOLTS, L04181 (AT INACTIVE DOOR)	630
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
2 EA.	DOOR SWEEP SEALS	MED. BRONZE

HW-13

3 EA.	HINGES, A8111	630
1 EA.	LATCHSET, F01	630

PROVIDE THE FOLLOWING AT DOOR NUMBERS 161, 162, 163, 164, 168, 169, 170, 171, 182, 183, 184, 185, 189, 190, 191, 192, 202, 203, 204, 205, 209, 210, 211, 212, 217, 218, 219, 220, 224, 225, 226, 227

1 EA. AUTOMATIC DOOR BOTTOM 630
PLUS DOOR ACOUSTICAL SEALS

HW-14

3 EA.	HINGES, A5111	630
1 EA.	CLOSER, C02021 (PAINT TO MATCH ADJACENT DOOR FRAME)	600
1 EA.	LOCKSET, F04 (W/LEVER HANDLES)	630
1 EA.	DOOR SWEEP SEAL	MED. BRONZE

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SECTION 08810

GLASS AND GLAZING

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 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 669	(1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 864	(1993) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM C 1036	(1991) Flat Glass
ASTM C 1048	(1992) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM C 1172	(1996) Laminated Architectural Flat Glass
ASTM C 1349	(1996) Architectural Flat Glass Clad Polycarbonate
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 773	(1988) Seal Durability of Sealed Insulating Glass Units
ASTM E 774	(1992) Sealed Insulating Glass Units
ASTM E 1300	(1994) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures

CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-378	(Basic) Putty: Linseed Oil Type, (for Wood-Sash-Glazing)

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA-01	(1990) Glazing Manual
GANA-04	(1995) Engineering Standards Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) 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 "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Glass; FIO. Glazing Accessories; FIO.

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Drawings

Glazing Materials and Accessories; FIO.

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-13 Certificates

Glass; FIO.

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

SD-14 Samples

Glass; FIO.

Two 203 x 254 mm samples of each of the following: tinted glass, one-way mirrored glass and insulating glass units.

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 5 degrees C 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.

PART 2 PRODUCTS

2.1 FLOAT GLASS

2.1.1 Annealed Glass

Annealed glass shall be Type I transparent flat type, Class 1 - clear , Quality q3 - glazing select, 65 percent light transmittance, .82 percent shading coefficient, conforming to ASTM C 1036. Color shall be gray.

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 spacer and dehydrated space conforming to ASTM E 773 and ASTM E 774. Aluminum spacer shall be roll-formed, with bent or tightly soldered 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 Low-E Insulating Glass

Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class 2-tinted with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be K-Value/Winter Nighttime 0.32, shading coefficient .5. Color shall be gray.

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 2-tinted, Condition A uncoated surface, Quality q3 - glazing select, 65 percent light transmittance, .82 percent shading coefficient conforming to ASTM C 1048 and GANA-04. Color shall be gray.

2.4 MIRRORS

2.4.1 Glass Mirrors

Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality q1 6 mm thick conforming to ASTM C 1036. Glass color shall be clear. 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 6 mm 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.

2.4.2 One-Way Mirrors

Glass for one-way mirrors shall be Type I transparent flat type, Class 1 clear, Glazing Quality q1, 6 mm thick conforming to ASTM C 1036. Glass shall be coated on one face with a hard adherent film of chromium or other approved coating of proven equivalent durability. Glass shall transmit not less than 5 percent nor more than 11 percent of total incident light in visible region, and shall reflect from front surface of coating not less than 45 percent of total incident light in visible region.

2.4.3 Mirror Accessories

2.4.3.1 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.

2.4.3.2 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 32 x 6 x 6 mm continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

2.4.3.3 Mirror Clips

Concealed fasteners of type to suit wall construction material shall be provided with clips.

2.5 GLAZING ACCESSORIES

2.5.1 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.

2.5.2 Sealant

Sealant shall be elastomeric conforming to ASTM C 920, Type S or M, Grade NS, Class 12.5, Use G, of type chemically compatible with setting blocks, preformed sealing tape and sealants used in manufacturing insulating glass. Color of sealant shall be as selected.

2.5.3 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

2.5.3.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

2.5.3.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

2.5.3.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.5.4 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-378for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

2.5.5 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.

PART 3 EXECUTION

3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA-01 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-01, glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire/safety rated 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 --

INVITATION FOR BIDS (IFB) VOLUME 2 of 2

SPACE IQT
ACADEMIC FACILITY

Vandenberg AFB, California

VOLUME 1 - BID DOCUMENTS and DIVISION 01 thru DIVISION 08
VOLUME 2 - DIVISION 09 thru DIVISION 16

IFB NO. DACA05- 98-B-0049
SPECIFICATION NO. 9872
DRAWING FILE NO. 221-25-1170

US ARMY CORPS OF ENGINEERS
Sacramento District/Los Angeles District

DIRECTIVE NO. DI No. 2, FY99 MCP
PROJECT NO. 983005

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SECTION 09510

ACOUSTICAL CEILINGS

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	(1995) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1992) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 1264	(1990) Standard Classification for Acoustical Ceiling Products
ASTM E 1414	(1991a) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.

UNDERWRITERS LABORATORIES (UL)

UL-05	(1996) Fire Resistance Directory

1.2 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 drawings.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Acoustical Ceiling System; FIO.

Manufacturer's descriptive data, catalog cuts, and installation

instructions.

SD-04 Drawings

Acoustical Ceiling System; FIO.

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.

SD-09 Reports

Ceiling Attenuation Class and Test;FIO.

Reports by an independent testing laboratory attesting that acoustical ceiling systems meet specified sound transmission requirements. Data attesting to conformance of the proposed system to Underwriters Laboratories requirements for the fire endurance rating listed in UL-05 may be submitted in lieu of test reports.

SD-13 Certificates

Acoustical Units; FIO.

Certificate attesting that the mineral based acoustical units furnished for the project contains recycled material and showing an estimated percent of such material.

SD-14 Samples

Acoustical Units; GA.

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

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 16 degrees C nor more than 29 degrees C and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units. Contractor shall as much as possible select materials manufacturers that reduce pollutant and waste, reuse resources and scrap, recycle waste, and reclaim mineral fiber ceilings instead of disposing into a landfill.

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.

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

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

2.1.1 Units for Exposed-Grid System

Type: III (mineral fiber with painted finish). Type III acoustical units shall have a minimum recycled material content of 18 percent.
Minimum NRC: 0.65 when tested on mounting No. E-400
Pattern: Z Sandrift, as specified on the Finish Schedule in the architectural drawings.
Nominal size: 600 by 600 mm.
Edge detail: Fineline .
Finish: Factory-applied standard finish.
Minimum LR coefficient: 0.89.
Minimum CAC: 40-44.

2.2 SUSPENSION SYSTEM

Suspension system shall be standard exposed-grid as shown on drawings, and shall conform to ASTM C 635 for intermediate-duty systems. Surfaces exposed to view shall be steel with a factory-applied white baked-enamel finish. Wall molding shall have a flange of not less than 14 mm. Inside and outside corner caps shall be provided.

2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 1330 N ultimate vertical load without failure of supporting material or attachment.

2.4 ACCESS PANELS

Access panels shall match adjacent acoustical units and shall be designed and equipped with suitable framing and fastenings for removal and replacement without damage. Panel shall be not less than 300 by 300 mm or more than 300 by 600 mm. . An identification plate of 0.8 mm thick aluminum, 19 mm in diameter, stamped with the letters "AP" and finished the same as the unit, shall be attached near one corner on the face of each access panel.

2.5 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.

2.6 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components shall be as specified on the Finish Schedule in the architectural drawings.

2.7 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.

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.

3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 75 mm from ends of each length and not more than 400 mm on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

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, if units weigh less than 5 kg per square m or if required for fire resistance rating.

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.

-- End of Section --

3.7 CLEANING AND PROTECTING

-- End of Section Table of Contents --

SECTION 09310

CERAMIC TILE

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 Latex Portland Cement Mortar
ANSI A108.5	(1992) Installation of Ceramic Tile with Latex-Portland Cement Mortar
ANSI A108.10	(1992) Installation of Grout in Tilework
ANSI A108.11	(1992) Interior Installation of Cementitious Backup Units
ANSI A118.4	(1992) Latex-Portland Cement Mortar
ANSI A118.6	(1992) Ceramic Tile Grouts
ANSI A118.9	(1992) Test Methods and Specifications for Cementitious Backer Units
ANSI A137.1	(1988) Ceramic Tile

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM C 33	(1993) Concrete Aggregates
ASTM C 144	(1993) Aggregate for Masonry Mortar
ASTM C 150	(1996) Portland Cement
ASTM C 206	(1984; R 1992) Finishing Hydrated Lime
ASTM C 207	(1991; R 1992) Hydrated Lime for Masonry Purposes
ASTM C 241	(1990) 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 648	(1984; R 1994) Breaking Strength of Ceramic Tile
ASTM C 847	(1995) Metal Lath
ASTM C 1026	(1987; R 1992) Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling
ASTM C 1027	(1984; R 1990) Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C 1028	(1989) 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-01	(1991) Design Manual IV Dimensional Stone

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(1996) Health Care Facilities

TILE COUNCIL OF AMERICA (TCA)

TCA-01	(1995) Handbook for Ceramic Tile Installation

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL

PROCEDURES:

SD-01 Data

Tile; FIO. Setting-Bed; FIO. Mortar, Grout, and Adhesive; FIO.

Manufacturer's catalog data.

SD-06 Instructions

Tile; FIO. Mortar and Grout; FIO.

Manufacturers preprinted installation and cleaning instructions.

SD-09 Reports

Testing; FIO.

Copy of results for electrical resistance tests.

SD-13 Certificates

Tile; FIO. Mortar, Grout, and Adhesive; FIO.
Certificates indicating conformance with specified requirements. A master grade certificate shall be furnished for tile.

SD-14 Samples

Tile; GA. Accessories; GA. Marble Thresholds; GA.

Samples of sufficient size to show color range, pattern, type and joints.

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.

1.4 ENVIRONMENTAL REQUIREMENTS

Ceramic tile work shall not be performed unless the substrate and ambient temperature is at least 10 degrees C and rising. Temperature shall be maintained above 10 degrees C 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 41 kg and 113 kg 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 0.5 maximum percent in accordance with ASTM C 373. Floor tile shall have a minimum static coefficient of friction of 0.5 in accordance with ASTM C 1028. Tile shall be Class III as rated by the manufacturer when tested in accordance with ASTM C 1027for abrasion resistance as related to foot traffic.

2.1.1 Porcelain Pavers and Mosaic Tile

Porcelain Pavers, Ceramic mosaic tile and trim shall be glazed and unglazed porcelain unpolished with sharply formed face. Mosaic tile size shall be 50 x 50 mm . Porcelain Paver size shall be 200 x 200 mm. Color shall be as specified on the Finish Schedule in the architectural drawings.

2.1.2 Glazed Wall Tile

Glazed wall tile and trim shall be cushion edged with matte glaze. Tile shall be 50 x 50 mm. Color shall be as specified on the Finish Schedule in the architectural drawings.

2.1.3 Accessories

Accessories shall be the built-in type of the same materials and finish as the wall tile. Accessories shall be provided as follows: Integral ceramic soap dish in showers.

2.1.4 Ceramic and Porcelain Trim

Conventional trim pieces are required as shown in the architectural drawings. Butt joints are not acceptable. Tile in vertical dimension shall be a whole tile. Wainscot height indicated shall be adjusted to the nearest whole tile dimension. Tile in horizontal dimension shall not be less than 3/4 of the manufactured dimension.

2.2 SETTING-BED

The setting-bed shall be composed of the following:

2.2.1 Aggregate for Concrete Fill

Aggregate shall conform to ASTM C 33. Maximum size of coarse aggregate shall not be greater than one-half the thickness of concrete fill.

2.2.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, light gray for wall mortar and medium gray for other uses to match color specified on the Finish Schedule in the architectural drawings.

2.2.3 Sand

Sand shall conform to ASTM C 144.

2.2.4 Hydrated Lime

Hydrated lime shall conform to ASTM C 206, Type S or ASTM C 207, Type S.

2.2.5 Metal Lath

Metal lath shall be flat expanded type conforming to ASTM C 847, and weighing not less than 1.4 kg/square meter.

2.2.6 Reinforcing Wire Fabric

Wire fabric shall conform to ASTM A 185. Wire shall be either 50 x 50 mm mesh, 16/16 wire or 38 x 50 mm mesh, 16/13 wire.

2.3 WATER

Water shall be potable.

2.4 MORTAR, GROUT, AND ADHESIVE

Mortar, grout, and adhesive shall conform to the following:

2.4.1 Latex-Portland Cement Mortar

ANSI A118.4.

2.4.2 Ceramic Tile Grout

ANSI A118.6; unsand portland cement groutdry-set groutlatex-portland cement grout.

2.4.3 Cementitious Backer Board

Cementitious backer units shall comply with ANSI A118.9.

2.5 MARBLE THRESHOLDS

Marble thresholds shall be of size required by drawings or conditions. Marble shall be Group A as classified by MIA-01. Marble shall have a fine sand-rubbed finish and shall be gray in color as specified on the Finish Schedule in the architectural drawings. 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
Latex portland cement mortar	3 mm in 2.4 meters	3.0 mm in 3 meters

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

Wall tile shall be installed in accordance with the TCA-01, method W244 in showers and method W241 for metal studs on other interior walls.

3.3.1 Latex-Portland Cement Mortar

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-01, method F112. Shower receptors shall be installed in accordance with TCA-01, method B415.

3.4.1 Workable or Cured Mortar Bed

Floor tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. Workable mortar bed materials and installation shall conform to ANSI A108.1A. Cured mortar bed and materials shall conform to ANSI A108.1B. Joints between quarry tile shall be between 6.35 mm and 9.53 mm) in width and shall be uniform in width.

3.4.2 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.

3.4.3 Ceramic Tile Grout

Ceramic Tile grout shall be prepared and installed in accordance with ANSI A108.10.

3.4.4 Waterproofing

Shower pans are specified in Section 15400 PLUMBING, GENERAL PURPOSE. Waterproofing under concrete fill shall conform to the requirements of Section 07112 BITUMINOUS WATERPROOFING.

3.4.5 Concrete Fill

Concrete fill shall be composed by volume of 1 part portland cement to 3 parts fine aggregate to 4 parts coarse aggregate, and mixed with water to as dry a consistency as practicable. The fill shall be spread, tamped, and

screeded to a true plane, and pitched to drains or leveled as shown. Concrete fill shall be thoroughly damp cured before application of setting-bed material . Concrete fill shall be reinforced with one layer of reinforcement, with the uncut edges lapped the width of one mesh and the cut ends and edges lapped not less than 50 mm. Laps shall be tied together with 1.3 mm wire every 250 mm along the finished edges and every 150 mm along the cut ends and edges. The reinforcement shall be supported and secured in the centers of concrete fills. The mesh shall be continuous; except where expansion joints occur, mesh shall be cut and discontinued across such joints. Reinforced concrete fill shall be provided under the setting-bed where the distance between the under-floor surface and the finished tile floor surface is 50 mm or greater, and shall be of such thickness that the mortar setting-bed over the concrete fill shall be not less than 19 mm nor more than 31 mm thick at any point.

3.4.6 Cementitious Backer Board

Cementitious backer units shall be installed in accordance with ANSI A108.11. Fasteners shall be type designed for cement board application.

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 6 mm in width and shall be grouted full as specified for ceramic tile.

3.6 CONTROL JOINTS

Joints shall be formed as indicated and sealed as specified in Section 07900 JOINT SEALING.

3.6.1 Walls

Control joints shall be provided at control joints in backing material. Wherever backing material changes, a control joint shall be formed to separate the different materials.

3.6.2 Floors

Control joints shall be provided over construction joints, control joints, and expansion joints in concrete slabs. Expansion joints shall extend through setting-beds and fill.

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 resinous grout or 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 --

3.6 PATCHING

-- End of Section Table of Contents --

SECTION 09250

GYPSUM WALLBOARD

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 580/A 580M	(1995a) Stainless Steel Wire
ASTM A 853	(1993) Steel Wire, Carbon, for General Use
ASTM B 164	(1993) Nickel-Copper Alloy Rod, Bar, and Wire
ASTM C 36	(1996) Gypsum Wallboard
ASTM C 79	(1995) Gypsum Sheathing Board
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 514	(1996) Nails for the Application of Gypsum Board
ASTM C 557	(1993a) Adhesive for Fastening Gypsum Wallboard to Wood Framing
ASTM C 630/C 630M	(1996a) Water-Resistant Gypsum Backing Board
ASTM C 645	(1996a) Nonstructural Steel Framing Members
ASTM C 754	(1996) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 840	(1996) Application and Finishing of Gypsum Board
ASTM C 931/C 931M	(1995a) Exterior Gypsum Soffit Board
ASTM C 955	(1996a) 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 C 960/C 960M	(1996) Predecorated Gypsum Board

ASTM C 1002	(1996a) Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
ASTM C 1047	(1995) Accessories for Gypsum Wallboard and Gypsum Veneer Base

GYPSUM ASSOCIATION (GA)

GA 216	(1996) Application and Finishing of Gypsum Board
GA 600	(1994) Fire Resistance Design Manual

UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(1997) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Steel Framing; FIO. Control Joints; FIO.

Drawings and installation details for ceiling framing, furring, special wall framing, and framed openings in walls and ceilings.

SD-13 Certificates

Gypsum Wallboard; FIO. Water-Resistant Gypsum Board; FIO. Steel Framing; FIO.

Certificates stating that the steel framing and gypsum wallboard meet the specified requirements.

1.3 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 3 years of documented successful experience.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered in original containers bearing the name of manufacturer, contents, and brand name. Materials shall be stored off the ground in a weathertight structure for protection. Gypsum boards shall be stacked flat, off floor and supported to prevent sagging and warpage. Adhesives and joint materials shall be stored in accordance with manufacturer's printed instructions. Damaged or deteriorated materials

shall be removed from jobsite.

1.5 ENVIRONMENTAL CONDITIONS

Environmental conditions for application and finishing of gypsum board shall be in accordance with ASTM C 840. During the application of gypsum board without adhesive, a room temperature of not less than 4 degrees C shall be maintained. During the application of gypsum board with adhesive, a room temperature of not less than 10 degrees C shall be maintained for 48 hours prior to application and continuously afterwards until completely dry. Building spaces shall be ventilated to remove water not required for drying joint treatment materials. Drafts shall be avoided during dry hot weather to prevent materials from drying too rapidly.

PART 2 MATERIALS

2.1 NON-LOADBEARING STUD WALLS

2.1.1 Studs

Studs for non-loadbearing walls shall conform to ASTM C 645. Studs shall be C-shaped, roll formed steel with minimum uncoated design thickness of 1.30 mm made from G40 hot-dip galvanized coated sheet.

2.1.2 Runner Tracks

Floor and ceiling runner tracks shall conform to ASTM C 645. Tracks shall be prefabricated, U-shaped with minimum 25 mm flanges, unpunched web, thickness to match studs, made from G40 hot-dip galvanized coated sheet.

2.2 SUSPENDED CEILING FRAMING

Main carrying channels and cross furring members for suspended gypsum board ceilings shall conform to ASTM C 645. Carrying channels shall be formed from 1.519 mm thick cold-rolled steel, hot-dipped galvanized after fabrication, 38 mm by 19 mm deep. Furring members shall be formed from cold-rolled steel, hot-dip galvanized after fabrication, 19 mm high by 19 mm deep.

2.3 GYPSUM BOARD

Gypsum board shall have square-cut ends, tapered or beveled edges and shall be maximum possible length. Gypsum board thickness shall be as shown.

2.3.1 Standard Gypsum Board

Regular gypsum board shall conform to ASTM C 36, and shall be 1200 mm wide.

2.3.2 Water-Resistant Gypsum Board

Water-resistant gypsum board shall conform to ASTM C 630/C 630M, regular, with water-resistant paper faces, paintable surfaces, and shall be 1200 mm width and maximum permissible length. Water-resistant gypsum board shall not be used on ceilings.

2.4 TRIM, MOLDINGS, AND ACCESSORIES

2.4.1 Taping and Embedding Compound

Taping and embedding compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use in embedding tape at gypsum wallboard joints and fastener heads, and shall be compatible with tape and substrate.

2.4.2 Finishing or Topping Compound

Finishing or topping compound shall conform to ASTM C 475. Compound shall be specifically formulated and manufactured for use as a finishing compound for gypsum board.

2.4.3 All-Purpose Compound

All-purpose compound shall be specifically formulated and manufactured to use as a taping and finishing compound, and shall be compatible with tape and substrate.

2.4.4 Joint Tape

Joint tape shall conform to ASTM C 475 and shall be as recommended by gypsum board manufacturer.

2.4.5 Trim, Control Joints, Beads, Stops and Nosings

Items used to protect edges, corners, and to provide architectural features shall be in accordance with ASTM C 1047.

2.5 FASTENINGS AND ADHESIVES

2.5.1 Nails

Nails shall conform to ASTM C 514. Nails shall be hard-drawn low or medium-low carbon steel, suitable for intended use. Special nails for predecorated gypsum board shall be as recommended by predecorated gypsum board manufacturer.

2.5.2 Screws

Screws shall conform to ASTM C 1002. Screws shall be self-drilling and self-tapping steel, Type G for gypsum board to gypsum board and Type S for light-gauge steel framing.

2.5.3 Hangers

Suspended ceiling runner channel hangers shall be soft, annealed steel wire not less than No. 8 SWG, conforming to ASTM A 853].

2.5.4 Wire and Clip Type Fastenings

Tie wire, clips, rings, and other fastenings shall be corrosion-resisting steel conforming to ASTM A 580/A 580M, composition 302, 304, or 316, Condition A, or nickel-copper alloy conforming to ASTM B 164, annealed condition except that walls, partitions, and other vertical surfaces not incorporated in ceiling construction may be erected with soft, annealed steel conforming to ASTM A 853.

2.5.4.1 Tie Wire

Tie wire for constructing partitions and vertical furring, for securing

metal lath to supports, and for lacing shall be not less than No. 18 SWG. Tie wire for other applications shall be not less than No. 16 SWG.

2.5.4.2 Clips

Clips used in lieu of tie wire for securing the furring channels to the runner channels in ceiling construction shall be made from strip not less than 3 mm thick or shall be hairpin clip, formed of wire not less than 0.4 mm nominal diameter. Other clips and rings or fastenings of similar materials shall be equivalent in holding power to that provided by tie wire for the specific application.

PART 3 EXECUTION

3.1 INTERIOR WALL FRAMING

Steel framing and furring members shall be installed in accordance with ASTM C 754. Members shall be in alignment with spacings not to exceed the maximum spacings indicated on drawings. Runners shall be aligned accurately at the floor and ceiling and securely anchored.

3.1.1 Wall Openings

The framing system shall provide for the installation and anchorage of the required subframes or finish frames for wall openings at doors, pass-through openings, and access panels. Partitions abutting continuous suspended ceilings shall be strengthened for rigidity at rough openings of more than 750 mm wide. Studs at openings shall be 0.84 mm (0.0329 in) minimum bare metal thickness and spot grouted at jamb anchor inserts. Double studs shall be fastened together with screws and secured to floor and overhead runners. Two studs shall be used for framing solid-core doors, doors over 900 mm wide and extra-heavy doors.

3.1.2 Wall Control Joints

Control joints for expansion and contraction in the walls shall be constructed with double studs installed 13 mm apart in interior walls or wall furrings where indicated on drawings. Control joint spacing shall not exceed 9 m. Ceiling-height door frames may be used as vertical control joints. Door frames of less than ceiling height may be used as control joints only if standard control joints extend to ceiling from both corners of top of door frame. Control joints between studs shall be filled with firesafing insulation in fire rated partitions.

3.2 SUSPENDED CEILING FRAMING

Suspended ceiling system framing shall be installed in accordance with ASTM C 754.

3.2.1 Hangers

Hangers shall be spaced not more than 1200 mm along runner channels and 900 mm in the other direction or 1050 mm in both directions unless otherwise indicated. Locations of hanger wires shall be coordinated with other work. Hangers at ends of runner channels shall be located not more than 150 mm from wall. Hanger wire shall be looped around bottom chord of open-web steel joists, or secured to structural elements with suitable fasteners. Sags or twists which develop in the suspended system shall be adjusted. Damaged or faulty parts shall be replaced.

3.2.2 Main Runners

Main runner channels shall be installed in accordance with ASTM C 754. Hanger wires shall be double strand saddle-tied to runner channels and the ends of hanger wire shall be twisted three times around itself. Main runners shall be located to within 150 mm of the paralleling wall to support the ends of cross furring. Main runners shall not come in contact with abutting masonry or concrete walls. Where main runners are spliced, ends shall be overlapped 300 mm with flanges of channels interlocked, and shall be securely tied at each end of splice with wire looped twice around the channels.

3.2.3 Furring Channels

Furring channels shall be spaced in accordance with ASTM C 754. Furring channels shall be secured to the runner channels and to structural supports at each crossing with tie wire, hairpin clips, or equivalent fastenings. Furring channels shall be located within 50 mm of parallel walls and beams, and shall be cut 13 mm short of abutting walls.

3.2.4 Ceiling Openings

Support members shall be provided as required at ceiling openings for access panels, recessed light fixtures, and air supply or exhaust. Support members shall be not less than 38 mm main runner channels and vertically installed suspension wires or straps shall be located to provide at least the minimum support specified herein for furring and wallboard attachment. Intermediate structural members not a part of the structural system, shall be provided for attachment or suspension of support members.

3.2.5 Light Fixtures

Light fixtures shall not be supported directly from suspended ceiling runners. Hanger wires for recessed or surface mounted light fixtures shall be anchored to structure at four corners of light fixtures, and additional wires shall be provided at appropriate locations to carry the weight of light fixtures.

3.2.6 Control Joints

Ceiling control joints for expansion and contraction shall be located where indicated on drawings. A control joint or intermediate blocking shall be installed where ceiling framing members change direction.

3.2.6.1 Interior Ceilings With Perimeter Relief

Control joints shall be installed so that linear dimensions between control joints shall not exceed 15 m in either direction nor more than 230 square meters.

3.3 APPLICATION OF GYPSUM BOARD

Gypsum board shall be installed in accordance with ASTM C 840 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.

3.3.1 Two-Ply Gypsum Board

Second layer of gypsum board shall be applied perpendicular to first layer with joints staggered and secured with mechanical fasteners. The use of adhesive shall be in accordance with ASTM C 840.

3.4 TRIM, MOLDINGS, AND ACCESSORIES INSTALLATION

Trim, moldings and accessories shall be installed in accordance with GA 216.

3.5 TAPING AND FINISHING

Gypsum board taping and finishing shall be performed in accordance with ASTM C 840. Boards shall be kept free of dirt, oil and other foreign matter that could cause a lack of bond. Screw heads, dents, gouges, and cut-outs shall be filled with joint compound and sanded. Accessories at exposed joints, edges, corners, openings, and similar locations shall be taped, floated with joint compound, and sanded to produce surfaces ready for gypsum board finishes.

3.6 PATCHING

Surface defects and damage shall be corrected as required to leave gypsum board smooth, uniform in appearance, and ready to receive finish as specified.

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SECTION 09650

RESILIENT FLOORING

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 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1996a) Critical Radiant Flux of floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1994a) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1995a) Vinyl Composition Floor Tile

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Resilient Flooring and Accessories; GA.

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-09 Reports

Resilient Flooring and Accessories; FIO.

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.

SD-14 Samples

Resilient Flooring and Accessories; GA.

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 60 by 100 mm. One of the three vinyl composition tile samples for each color shall be step abraded to demonstrate that the color and pattern are uniformally distributed throughout the thickness of the tile.

1.3 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 21 degrees C 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.

1.4 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 21 degrees C and below 38 degrees C for 2 days before application, during application and 2 days after application. A minimum temperature of 13 degrees C shall be maintained thereafter.

1.5 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of5 tiles for each 1000 tiles . Extra materials shall be from the same lot as those installed. Extra base material composed of 6 m of each color shall be furnished.

PART 2 PRODUCTS

2.1 VINYL-COMPOSITION TILE TYPE

Vinyl-composition tile shall conform to ASTM F 1066, Class 2,(through pattern tile), Composition 1, asbestos-free, and shall be 300 mm square and 3.2 mm 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 RESILIENT BASE

Base shall be manufacturers standard rubbercoved style (installed with carpet and resilient flooring). Base shall be 100 mm high and a minimum 3 mm thick. Preformed outside corners shall be furnished. Continuous rolls rather than 1200 mm lengths shall be used in order to give a smooth finished appearance with a minimum of joints between corners. Color shall

be as specified on the Finish Schedule in the architectural drawings.

2.3 TRANSITION STRIP

A rubber transition strip tapered to meet abutting material shall be provided.

2.4 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

2.5 POLISH

Polish shall conform to ASTM D 4078.

2.6 CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07900JOINT SEALING.

2.7 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be as specified on the Finish Schedule in the architectural 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 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.

3.6 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.

3.7 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.

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SECTION 09680

CARPET

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 TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM-16	(1993) Test Method: Colorfastness to Light
AATCC TM-134	(1991) Test Method: Electrostatic Propensity of Carpets
AATCC TM-165	(1993) Test Method: Colorfastness to Crocking: Carpets - AATCC Crockmeter Method

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 418	(1993) Pile Yarn Floor Covering Construction
ASTM D 1423	(1992) Twist in Yarns by the Direct Counting Method
ASTM D 3278	(1989) Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 648	(1996a) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1994) Commercial Carpet Installation Standard

CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1630	Standard for the Surface Flammability of Carpet and Rugs

40 CFR 247	Guidelines for Procurement of Products That Contain Recycled Material

GERMANY INSTITUTE FOR STANDARDIZATION (DEUTSCHES INSTITUTE FUR NORMUNG) (DIN)

DIN 54318	(1986) Machine-Made Textile Floor Coverings; Determination of Dimensional Changes Due to the Effects of Varied Water and Heat Conditions; Identical with ISO 2551 Edition 1981

U.S. ENVIRONMANTAL PROTECTION AGENCY

SECTION 6002	Resource Conservation and Recovery Act, 9RCRA)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Carpet and Accessories; GA.

Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory.

SD-04 Drawings

Installation; FIO.

Three copies of drawings indicating areas receiving carpet, carpet types, textures and patterns, direction of pile, location of seams, and locations of edge molding.

SD-06 Instructions

Carpet and Accessories; FIO.

Three copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

SD-09 Reports

Moisture and Alkalinity Tests; FIO.

Three copies of test reports of moisture and alkalinity content of concrete slab stating date of test, person conducting the test, and the area tested.

SD-13 Certificates

Carpet and Accessories; FIO.

Certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet and carpet with cushion material conforms to the standards specified.

SD-14 Samples

Carpet and Accessories; GA.

a. Carpet: Two "Production Quality" samples 675 x 450 mm of each carpet proposed for use, showing quality, pattern, and color specified.

b. Vinyl or Aluminum Moldings: Two pieces of each type at least 300 mm.

c. Special Treatment Materials: Two samples showing system and installation method.

SD-19 Operation and Maintenance Manuals

Carpet and Accessories; FIO.

Three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

1.3 REGULATORY REQUIREMENTS

Carpet and adhesives 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 IAQ Carpet Testing Program, and minimizes the impact on indoor air quality. Carpet shall have the highest percentage of recovered materials as is practicable in order to comply with the Resource Conservation and Recovery Act, (RCRA) Section 6002 and 40 CFR 247.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Materials shall be stored in a clean, dry, well ventilated area, protected from damage and soiling, and shall be maintained at a temperature above 16 degrees C for 2 days prior to installation.

1.5 ENVIRONMENTAL REQUIREMENTS

Areas in which carpeting is to be installed shall be maintained at a temperature above 16 degrees C for 2 days before installation, during installation, and for 2 days after installation. A minimum temperature of 13 degrees C shall be maintained thereafter for the duration of the contract. Traffic or movement of furniture or equipment in carpeted area shall not be permitted for 24 hours after installation. Other work which would damage the carpet shall be completed prior to installation of carpet.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

1.7 EXTRA MATERIAL

Extra material from same dye lot consisting of full width continuous broadloomanduncut carpet tiles shall be provided for future maintenance. A minimum of five (5) percent of total square meters of each carpet type, pattern, and color shall be provided.

PART 2 PRODUCTS

2.1 CARPET TYPE C1, C2, C3 (Roll Carpet) CPT1, CPT2, CPT3 (Carpet Tile)

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

2.1.1 Physical Characteristics

Carpet shall comply with the following:

a. Carpet Construction: Tufted loop pile - C1/C2/C3, CPT1.

b. Type: Broadloom C1, C2, C3- 3.6 m minimum usable carpet width Modular tile CPT1 450 x 450 mm square with 0.15 percent growth/shrink rate in accordance with DIN 54318.

c. Pile Type: Level-loop C1/C2/C3, CPT1.

d. Pile Fiber: Commercial branded 6,6 nylon continuous filament C1/C2/C3, CPT1.

e. Pile or Wire Height: Minimum 2.59 mm C1/CPT1 and minimum 3.86 mm C2/C3 in accordance with ASTM D 418.

f. Yarn Ply: Minimum 2-C1/C2/C3, CPT1 in accordance with ASTM D 1423.

g. Gauge or Pitch: Minimum 39.37 mm C1/C2/C3, CPT1 in accordance with ASTM D 418.

h. Stitches or Rows/Wires: Minimum 47.24 per square meter.C1/C2/C3, CPT1

i. Finished Pile Yarn Weight: Minimum 882 kg per square meter ,C1/C2/C3, CPT1. This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.

j. Pile Density: Minimum 333.10 kg per square meter C1/CPT1 and minimum 246.38 kg per square meter C2/C3.

k. Dye Method:
Solution/Yarn (or Skein) dyed - C1/CPT1 and Solution dyed -C2/C3.

l. Backing Materials: Primary backing materials shall be those customarily used and accepted by the trade for each type of carpet polypropylene. Secondary backing to suit project requirements shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

2.1.2 Performance Requirements

a. Static Control: Static control shall be provided to permanently control static buildup to less than 2.0 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM-134.

b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet in corridor 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.

c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile.

e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM-165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.

f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM-16 and shall have a minimum 4 grey scale rating after 40 hours.

g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 440 N/m.

2.2 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers for installation of carpet shall be waterproof, nonflammable, meet local air-quality standards, and shall be as recommended by the carpet manufacturer. Seam adhesive shall be waterproof, nonflammable, and nonstaining as recommended by the carpet manufacturer. Release adhesive for modular tile carpet shall be as recommended by the carpet manufacturer. Adhesives flashpoint shall be minimum 60 degrees C in accordance with ASTM D 3278.

2.3 MOLDING

Vinyl molding shall be heavy-duty and designed for the type of carpet being installed. Floor flange shall be a minimum 50 mm wide. Color shall be as specified on the Finish Schedule in the architectural drawings.

2.4 TAPE

Tape for seams shall be as recommended by the carpet manufacturer for the type of seam used in installation.

2.5 COLOR, TEXTURE, AND PATTERN

Carpet shall have a random pattern design, containing a minimum of three (3) distinct colors. Color, texture, and pattern shall be as specified on the Finish Schedule in the architectural drawings.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Carpet shall not be installed on surfaces that are unsuitable and will prevent a proper installation. Holes, cracks, depressions, or rough areas shall be repaired using material recommended by the carpet or adhesive manufacturer. Floor shall be free of any foreign materials and swept broom clean. Before beginning work, subfloor shall be tested with glue and carpet to determine "open time" and bond.

3.2 MOISTURE AND ALKALINITY TEST

Concrete slab shall be tested for moisture content and excessive alkalinity in accordance with CRI 104. The moisture content shall not exceed a hygrometer reading of 65 percent.

3.3 PREPARATION OF CONCRETE SUBFLOOR

Installation of the carpeting shall not commence until concrete substrate is at least 90 days old. The concrete surfaces shall be prepared in accordance with instructions of the carpet manufacturer. Type of concrete sealer, when required, shall be compatible with the carpet.

3.4 INSTALLATION

Installation shall be in accordance with the manufacturer's instructions and CRI 104. Edges of carpet meeting hard surface flooring shall be protected with molding. Installation shall be in accordance with the molding manufacturer's instructions.

3.4.1 Broadloom Installation

Broadloom carpet shall be installed hook and loop system or direct glue down and shall be smooth, uniform, and secure, with a minimum of seams. Seams shall be uniform, unnoticeable, and treated with a seam adhesive. Hook tape shall be applied at seams and around the perimeter of the room. Loop fabric shall be applied to the under side of the carpet. Side seams shall be run toward the light where practical and where such layout does not increase the number of seams. Breadths shall be installed parallel, with carpet pile in the same direction. Patterns shall be accurately matched. Cutouts, as at door jambs, columns and ducts shall be neatly cut and fitted securely. Seams at doorways shall be located parallel to and centered directly under doors. Seams shall not be made perpendicular to doors or at pivot points. Seams at changes in directions of corridors shall follow the wall line parallel to the carpet direction.

3.4.2 Modular Tile Installation

Modular tiles shall be installed free lay with release adhesive applied to

the tiles around the perimeter and stress point for rolling loads, and shall be snugly jointed together. Tiles shall be laid in the same direction with accessibility to the subfloor where required.

3.5 CLEANING AND PROTECTION

3.5.1 Cleaning

After installation of the carpet, debris, scraps, and other foreign matter shall be removed. Soiled spots and adhesive shall be removed from the face of the carpet with appropriate spot remover. Protruding face yarn shall be cut off and removed. Carpet shall be vacuumed clean.

3.5.2 Protection

The installed carpet shall be protected from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Traffic shall be restricted for at least 45 hours. Protective covering shall be removed when directed by the Contracting Officer.

3.6 REMNANTS

Remnants remaining from the installation, consisting of scrap pieces more than 600 mm in dimension with more than 0.6 square meters total, shall be provided. Non-retained scraps shall be removed from site.

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SECTION 09900

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SECTION 09900

PAINTING, GENERAL

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 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2246	(Rev A) Paint, Latex (Gloss, Interior)
CID A-A-2247	(Basic) Paint, Latex (Semigloss, Interior)
CID A-A-2340	(Basic) Primer Coating (Latex, White, for Gypsum Wallboard)
CID A-A-2834	(Rev A) Urethane, Waterborne (Low VOC, Clear)

FEDERAL SPECIFICATIONS (FS)

FS TT-E-489	(Rev J) Enamel, Alkyd, Gloss, Low VOC Content
FS TT-P-19	(Rev D) Paint, Latex (Acrylic Emulsion, Exterior Wood and Masonry)
FS TT-P-645	(Rev B) Primer, Paint, Zinc-Molybdate, Alkyd Type

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 5	(1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)
SSPC Paint 26	(1991) Slow Drying Linseed Oil Black Maintenance Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Paint; FIO.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials [when the required quantity of a particular batch is 200 L or less.] [regardless of quantities in states where VOC content limitations apply].

SD-06 Instructions

Mixing and Thinning; FIO. Application; FIO.

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 for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

SD-09 Reports

Paint; FIO.

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 200 L:

a. A test report showing that the proposed batch to be used meets all specification requirements, or:

b. A test report showing that a previous batch of the same formulation as the batch to be used met all specification

requirements, plus, on the proposed batch to be used, a report of test results for properties of weight per liter, viscosity, fineness of grind, drying time, color, and gloss.

SD-13 Certificates

Lead; FIO. Mildewcide and Insecticide; FIO. Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-14 Samples

Paint; FIO.

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 liter sample of each color and batch, except for quantities of 200 liters or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated 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 of manufacturer. Pigmented paints shall be furnished in containers not larger than 20 liters. Paints and thinner 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 4 and 35 degrees C. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.4 APPROVAL OF MATERIALS

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 7 and 35 degrees C when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 10 and 32 degrees C. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

1.6 SAFETY AND HEALTH

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 the CONTRACT CLAUSES. 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.

1.6.1 Worker Exposures

Exposure of workers to hazardous chemical substances shall not exceed limits as established by ACGIH-02, or as required by a more stringent applicable regulation.

1.6.2 Toxic Compounds

Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the Contracting Officer.

1.6.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MSDS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1.6.4 Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

PART 2 PRODUCTS

2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the respective specifications listed for use in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 200 liters or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.3 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.4 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter 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-primmed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Masonry Surfaces

Masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

3.2.4 Gypsum Board Surfaces

Gypsum board surfaces shall be dry and shall have all loose dirt and dust removed by brushing with a soft brush, rubbing with a 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.

3.2.5 Mastic-Type Surfaces

Mastic-type surfaces shall be prepared by removing foreign material.

3.2.6 Wood Surfaces

Wood surfaces shall be cleaned of foreign matter. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter, unless otherwise authorized. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints. Small, dry seasoned knots shall be scraped, cleaned, and given a thin coat of commercial knot sealer, before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or, if it is still soft, removed with mineral spirits or turpentine, and the resinous area shall be thinly coated with knot sealer. Finishing nails shall be set, and all holes and surface imperfections shall be primed. After priming, holes and imperfections in finish surfaces shall be filled with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler shall be compatible with subsequent coatings.

3.2.6.1 Interior Wood Stain

Interior wood surfaces to receive stain shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth.

3.2.7 Previously Painted Surfaces

Previously painted surfaces damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas. Edges of chipped paint shall be feather edged and sanded smooth. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8. New, proposed coatings shall be compatible with existing coatings. If existing surfaces are glossy, the gloss shall be reduced.

3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 0.125 L of suitable thinner per liter. 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.

3.4 APPLICATION

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. 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. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. 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. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH-02, or as required by a more stringent applicable regulation. Interior work zones having a volume of 280 cubic meters or

less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3.4.3 First Coat

The first coat on gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. The first coat on both faces of wood doors shall be applied at essentially the same time. Glazed doors and sashes shall be given the specified coating system within 3 weeks of the time they are glazed, but not before the glazing material has set; paint shall overlay glass about 1.78 mm all around. Each varnish coat shall be sanded lightly prior to application of subsequent coats.

3.4.4 Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3.4.5 Stains

On smooth exterior wood surfaces such as the planed face of bevel siding, the stain shall be applied at a spreading rate of 9.8 to 12.3 square meters per liter. On rough surfaces such as an unplaned or scarred face of bevel siding, the stain shall be spread at the rate of 4.9 to 6.1 square meters per liter or as recommended by the manufacturer. Oil-type stain shall be applied by brushing with the grain for the full length of the board or course of siding.

3.4.6 Fillers

Masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

3.4.6.1 Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. 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.

3.4.7 PIPE COLOR CODE MARKING

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, at not more than 12 meter spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the color listed in TABLE I and the size listed in TABLE II. The arrows shall be installed adjacent to each band to indicate the direction of flow in the pipe. The legends shall be printed in upper-case black letters as listed in TABLE I. Letter sizes shall be as listed in TABLE II. Marking shall be painted or applied using colored, pressure-sensitive adhesive markers of standard manufacture. Paint shall be as specified for insulated and uninsulated piping.

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Cold water (potable)	Green	White	POTABLE WATER
Fire protection water	Red	White	FIRE PR. WATER
Hot water (domestic)	Green	White	H.W.
Hot water recirculating (domestic)	Green	White	H.W.R.
High temp. water supply	Yellow	Black	H.T.W.S.
High temp. water return	Yellow	Black	H.T.W.R.
Boiler feed water	Yellow	Black	B.F.
Low temp. water supply (heating)	Yellow	Black	L.T.W.S.
Low temp. water return (heating)	Yellow	Black	L.T.W.R.
Condenser water supply	Green	White	COND. W.S.
Condenser water return	Green	White	COND. W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Yellow	Black	TR. WATER
Chemical feed	Yellow	Black	CH. FEED
Compressed air	Yellow	Black	COMP. AIR
Natural gas	Blue	White	NAT. GAS
Freon	Blue	White	FREON
Fuel oil	Yellow	Black	FUEL OIL
Steam	Yellow	Black	STM.
Condensate	Yellow	Black	COND.

TABLE II. COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (mm)	Width of Color Band (mm)	Arrow Length x Width (mm)	Size of Legend Letters and Numerals (mm)
Less than 38	200	200 x 57	13
38 to 60	200	200 x 57	19
60 to 150	300	200 x 57	31
200 to 225	600	300 x 110	63
Over 250	800	300 x 115	88

3.4.8 MISCELLANEOUS PAINTING

3.4.8.1 Lettering

Lettering shall be provided as scheduled on the drawings, shall be block type, and shall be black enamel, finished with a protective coating of spar varnish. Samples shall be approved before application.

3.4.9 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

3.4.10 SURFACES NOT TO BE PAINTED

Surfaces in the following areas are not to be painted: unexposed interior ferrous surfaces, and sized vapor barrier jacketing over insulation pipes,in unexposed locations that do not require color coding. In addition surfaces of hardware, fittings, and other factory finished items shall not be painted.

3.4.11 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.4.12 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by ------or------ between optional systems or coats.

EXTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Ferrous metal unless otherwise specified. (including doors and frames)	SSPC Paint 25	FS TT-E-489	FS TT-E-489
Galvanized metal.	FS TT-P-19	FS TT-E-2784	FS TT-E-2784

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Gypsum Board and concrete masonry units	CID A-A-2340	CID A-A-2247	CID A-A-2247
Gypsum board ceilings in restrooms and janitor rooms unless otherwise specified.	CID A-A-2340	FS TT-E-2784	FS TT-E-2784
Ferrous metal unless otherwise specified.	FS TT-P-645	FS TT-E-2784	FS TT-E-2784
Galvanized metal:	FS TT-P-19	Two coats of paint to match adjacent areas	
Wood: stain and varnish finishes as indicated on drawings.	Commercially available stain	FS TT-V-121 In addition a fourth coat of FS TT-V-121	FS TT-V-121
Metal: Convector enclosures, electrical conduit runs, metallic tubing, uninsulated ducts and pipes, pipe hangers, louvers, grilles, and air outlets in areas having painted adjacent surfaces.	Aluminum and ferrous metal: FS TT-P-645	None	None
	Galvanized surface: FS TT-P-19	CID A-A-2247	CID A-A-2247

INTERIOR PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat
Facing of vapor barrier jackets of presized or adhesive finished cloth over insulation on pipes, ducts, and equipment.	Two coats of paint to match adjacent areas.		None
Oil-based caulking compound.	FS TT-P-38	Same as adjacent areas	

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SECTION 10160

TOILET PARTITIONS

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SECTION 10160

TOILET PARTITIONS

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.

CODE OF FEDERAL REGULATIONS (CFR)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities

FEDERAL SPECIFICATIONS (FS)

FS RR-P-1352	(Rev C) Partitions, Toilet, Complete

FEDERAL STANDARDS (FED-STD)

FED-STD 795	(Basic) Uniform Federal Accessibility Standards

1.2 SYSTEM DESCRIPTION

Toilet partition system, including toilet enclosures, room entrance screens, and urinal screens, shall be a complete and usable system of panels, hardware, and support components. The partition system shall be provided by a single manufacturer and shall be a standard product as shown in the most recent catalog data. The partition system shall comply with FED-STD 795 and 36 CFR 1191 for areas as shown.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Toilet Partition System; FIO.

Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

SD-04 Drawings

Toilet Partition System; FIO.

Drawings showing plans, elevations, details of construction, hardware,

reinforcing, fittings, mountings, and anchorings.

SD-14 Samples

Toilet Partition System; GA.

Manufacturer's standard color charts and color samples to match color specified on the Finish Schedule in the architectural drawings.

1.4 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 and free from dust, water, or other contaminants and shall have easy access for inspection and handling.

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 TOILET ENCLOSURES

Toilet enclosures shall conform to FS RR-P-1352, Type I, Style A]. Width, length and height of toilet enclosures shall be as shown. Finish surface of panels shall be baked enamel finish 1. Panels indicated to receive toilet paper holders or grab bars as specified in Section 10800 TOILET ACCESSORIES shall be reinforced for the reception of the items required. Grab bars shall comply with FED-STD 795 and 36 CFR 1191.

2.2 URINAL SCREENS

Urinal screens shall conform to FS RR-P-1352, Type III, Style D. Finish surface of screens shall be baked enamel finish 1. Width and height of urinal screens shall be as shown.

2.3 HARDWARE

Hardware for the toilet partition system shall conform to FS RR-P-1352 for the specified type and style of partitions. Hardware finish shall be highly resistant to alkalies, urine, and other common toilet room acids.

2.4 COLORS

Color of finishes for toilet partition system components shall be as specified on the Finish Schedule in the architectural drawings.

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 through-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 5 mm and shall rest open at approximately 30 degrees when unlatched. Baked enamel finish shall be touched up with the same color of paint that was used for the finish. Toilet partitions shall be cleaned in accordance with approved manufacturer's instructions and shall be protected from damage until accepted.

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SECTION 10250

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SECTION 10250

MISCELLANEOUS ARCHITECTURAL SPECIALTIES

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 346-54T	Porcelain, Gloss Variation
ASTM F152	Cork, Tensil Strength

FEDERAL SPECIFICATIONS (FS)

FS GG-S-00172	(Rev D) Screen, Projection

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Shop Drawings

Shop Drawings; FIO.

Prepare and submit shop drawings, in accordance with Section 1300, SUBMITTALS, for all items showing installation details, fabrication details, materials, hardware, reinforcing, mountings, anchorage, and other pertinent data to evaluate the submittals. No fabrication shall begin until shop drawings have been approved.

SD-06 Installation and Maintenance Instructions
; GA.

Manufacturer's recommended installation and maintenance instructions shall be submitted and approved before delivery of materials to the site.

PART 2 PRODUCTS

2.1 ELECTRICAL/OPERABLE PROJECTION SCREEN

Electrically operated projection screen shall be in accordance with FS GG-S-00172 and be recessed ceiling mounted with multi-media format, matte white or glass beaded surface. Screen shall be prewired for two switches,

controls shall operate on low-voltage (24v) and permit switching at any time. When screen is rolled up, it shall show only a closed trap door that is white. Motor shall be mountaed above the ceiling and shall be UL and CSA listed and have internal gears, lifetime lubrication, automatic thermal overload cut-off, and brake for instant stopping at any point or when fully extended or retracted. Screen shall be mounted where shown on the drawings, in accordance with SECTION: ELECTRICAL WORK, INTERIOR. The screen shall be nominally 2438 mm high by 2438 mm wide.

2.2 PORCELAIN MARKER BOARD

Porcelain marker board shall conform to ASTM-C-346-54T for gloss variation. Marker board shall be mounted 900 mm from the finished floor, in accordance with the manufacturer's instructions. Marker boards shall be 1200 mm high by 1800 mm wide. Marker board face shall be porcelain enamel steel .55 mm. Board shall be capable of supporting papers by means of magnets. The writing surface shall resist wear and damage from shock and abrasion and shall not dent, shatter or crack. The surfaces shall retain their origninal color (white), writing and erasing qualities and shall not become glossy or shiny in normal use. Facing sheet shall be .55 mm, laminated to fiberboard with aluminum backing sheet bonded with flexible adhesive. Board shall have extruded aluminum trim, chalk tray, end plates and display rail with cork insert.

2.3 TACKBOARDS

Tackboard shall be 7 mm thick pure granulated natural cork, free from hardback, combined with polyurethane resin binder, and laminated to backing sheet. Density not to be less than 11 lbs. per cubic foot. Cork shall be free from irregularities including knife marks. Tensil strength shall be in accordance with ASTM F 152. Compressibility and recovery shall be in accordance with ASTM F 36. Backing shall be the manufacturer's engineered industrial grade 7 mm thick high density particle board, formed and bonded with resin to create a substrate for improved laminating. Color shall be integral throughout thickness. Board shall have extruded aluminum trim. Mitered corners shall have interior corner lock for added stability.

PART 3 EXECUTION

3.1 INSTALLATION

Furnish and install all miscellaneous building specialties indicated and specified herein, and as shown on the drawings. All items shall be furnished complete with all accessories, anchors, bolts, screws, braces, etc., as may be required to complete the work.

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SECTION 10260

WALL AND CORNER PROTECTION

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	(1980) Designation System for Aluminum Finishes

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1993) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 221	(1995a) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM D 256	(1993a) Determining the Pendulum Impact Resistance of Notched Specimens of Plastics
ASTM D 635	(1991) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM E 84	(1995) Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1992) Fire Doors and Windows

SOCIETY OF AMERICAN AUTOMOTIVE ENGINEERS (SAE)

SAE J1545	(1986) Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Color Trim

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Corner Guards; GA. Wall Guards (Bumper Guards); GA. ; . ; .

Manufacturer's descriptive data, catalog cuts, installation instructions, and recommended cleaning instructions.

SD-04 Drawings

Corner Guards; FIO. Wall Guards (Bumper Guards); FIO. ; . ; .

Drawings indicating locations and typical elevations of each type of item. Drawings shall show vertical and horizontal dimensions, full size sections, thickness of materials, and fastening details.

SD-13 Certificates

Corner Guards; FIO. Wall Guards (Bumper Guards); FIO. ; . ; .

Statements attesting that the items comply with specified fire and safety code requirements.

SD-14 Samples

Finish; GA.

Manufacturer's standard samples indicating color and texture of materials requiring color and finish selection.

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 trademarks intact. Materials shall be kept dry, protected from weather and damage, and stored under cover. Materials shall be stored at approximately 21 degrees C for at least 48 hours prior to installation.

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 GENERAL

To the maximum extent possible, corner guards, and wall guards (bumper guards), shall be the standard products of a single manufacturer and shall be furnished as detailed. Drawings show general configuration of products required, and items differing in minor details from those shown will be acceptable.

2.1.1 Resilient Material

Resilient material shall consist of high impact resistant extruded acrylic vinyl, polyvinyl chloride, or injection molded thermal plastic and shall conform to the following:

2.1.1.1 Minimum Impact Resistance

Minimum impact resistance shall be 960.8 N.m/m (18 ft. lb/sq. inch) when tested in accordance with ASTM D 256, (Izod impact, ft. lbs per sq inch notched).

2.1.1.2 Fire Rating

Fire rating shall be Class 1 when tested in accordance with ASTM E 84, having a maximum flame spread of 25 and a smoke developed rating of 450 or less. Material shall be rated self extinguishing when tested in accordance with ASTM D 635. Material shall be labeled and tested by an approved nationally known testing laboratory. Resilient material used for protection on fire rated doors and frames shall be listed by the testing laboratory performing the tests. Resilient material installed on fire rated wood/steel door and frame assemblies shall have been tested on similar type assemblies. Test results of material tested on any other combination of door/frame assembly will not be acceptable.

2.1.1.3 Integral Color

Colored components shall have integral color and shall be matched in accordance with SAE J1545 to within plus or minus 1.0 on the CIE-LCH scales.

2.2 CORNER GUARDS

2.2.1 Resilient Corner Guards

Corner guard units shall be surface mounted type, radius formed to profile shown. Corner guards shall extend from floor to ceiling. Mounting hardware, cushions, and base plates shall be furnished. Assembly shall consist of a snap-on corner guard formed from high impact resistant resilient material, minimum 1.98 mm thick, mounted on a continuous aluminum retainer. Extruded aluminum retainer shall conform to ASTM B 221, alloy 6063, temper T5 or T6. Flush mounted type guards shall act as a stop for adjacent wall finish material. Factory fabricated end closure caps shall be furnished for top and bottom of surface mounted corner guards. Flush mounted corner guards installed in fire rated wall shall maintain the rating of the wall. Insulating materials that are an integral part of the corner guard system shall be provided by the manufacturer of the corner guard system. Exposed metal portions of fire rated assemblies shall have a paintable surface.

2.2.2 Stainless Steel Corner Guards

Stainless steel corner guards shall be fabricated of 1.58 mm thick material conforming to ASTM A 167, type 302 or 304. Corner guards shall extend from floor to ceiling on outside corners in corridor 158 by the ADPE Storage/Shop, Room 157. Corner guard shall be formed to dimensions shown.

2.3 WALL GUARDS (BUMPER GUARDS)

2.3.1 Wall Guards

Wall guards shall be provided with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories standard with the manufacturer. Extruded aluminum retainers shall conform to ASTM B 221, alloy 6063, temper T5 or T6. End caps and corners shall be field adjustable to assure close alignment with handrails and wall guards. Wall guards shall be profile as shown.

2.4 TRIM, FASTENERS AND ANCHORS

Vinyl trim, fasteners and anchors shall be provided for each specific installation as shown.

2.5 FINISH

2.5.1 Aluminum Finish

Finish for aluminum shall be in accordance with AA DAF-45. Concealed aluminum shall be mill finish.

2.5.2 Stainless Steel Finish

Finish for stainless steel shall be in accordance with NAAMM-500 Series, finish number 4.

2.5.3 Resilient Material Finish

Finish for resilient material shall be stipple texture with colors in accordance with SAE J1545.

2.6 ADHESIVES

Adhesive for resilient material shall be in accordance with manufacturers recommendations.

2.7 COLOR

Color shall be as specified on the Finish Schedule in the architectural drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Corner Guards and Wall Guards (Bumper Guards)

Material shall be mounted at location indicated in accordance with manufacturer's recommendations.

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SECTION 10270

RAISED FLOOR SYSTEM

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 A208.1	(1993) Particleboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1995a) Surface Burning Characteristics of Building Materials
ASTM E 648	(1995a) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CEILINGS AND INTERIOR SYSTEMS CONTRACTORS ASSOCIATION (CISCA)

CISCA-01	(1987) Recommended Test Procedures for Access Floors

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1983) Construction and Industrial Plywood

FEDERAL SPECIFICATIONS (FS)

FS SS-T-312	(Rev B; Int Am 1; Notice 1) Tile, Floor: Asphalt, Rubber, Vinyl, and Vinyl Composition

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01	(1994) Uniform Building Code (3 Vol. set)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1991) High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 75	(1995) Protection of Electronic Computer/Data Processing Equipment
NFPA 99	(1996) Health Care Facilities

UNDERWRITERS LABORATORIES (UL)

UL 779 (1995) Electrically Conductive Floorings

1.2 SYSTEM DESCRIPTION

Raised flooring shall be installed at the location and elevation and in the arrangement shown on the drawings. The floor system shall be of the stringer type, complete with all supplemental items, and shall be the standard product of a manufacturer specializing in the manufacture of raised floor systems.

1.2.1 Floor Panels

Floor panel testing shall be conducted in accordance with CISCA-01. 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 5563 N concentrated load without deflecting more than 2.03 mm and without permanent deformation in excess of 0.25 mm in any of the specified tests. Floor panels shall be capable of supporting 14.36 KPa per square meter uniform live load without deflection more than 1.02 mm. Floor panels shall be capable of supporting 4450 N rolling load without deflecting more than 1.02 mm and without permanent deformation in excess of 0.51 mm. In accordance with CISCA-01, 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 1110 N concentrated load at midspan without permanent deformation in excess of 0.25 mm.

1.2.3 Pedestals

Pedestals shall be capable of supporting a 22.24 kN 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 113 Nm.

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 4.45 kN, 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 0.15 L/s of air per linear meter of joint subjected to 2.5 mm, water gauge, positive pressure in the plenum.

1.2.7 Grounding

The raised floor system shall be grounded for safety hazard and static

suppression.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Raised Floor System; FIO.

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 ICBO-01. Certified copies of test reports may be submitted in lieu of calculations.

SD-04 Drawings

Raised Floor System; GA.

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-09 Reports

Tests; GA]. Testing of Electrical Resistance; GA.

Certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified.

SD-13 Certificates

Raised Floor System; FIO.

Certificate of compliance attesting that the raised floor system meets specification requirements.

SD-14 Samples; FIO.

One sample of each panel type and suspension system proposed for use.

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 4 and 32 degrees C 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 space for each 100 or fraction thereof required.

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 450 by 450 mm. Finished panels shall be within a 0.25 mm tolerance of the nominal size, and shall be square within a tolerance of 0.38 mm measured corner-to-corner. The top surface of panels shall be flat within a 0.51 mm tolerance measured corner-to-corner. Panels shall be permanently marked to indicate load rating and model number.

2.1.1.1 Steel 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.

2.1.2 Floor Covering

Floor panels shall be surfaced with materials firmly bonded in place with waterproof adhesive. The electrical resistance shall remain stable over the life expectancy of the floor covering. Any antistatic agent used in the manufacturing process shall be an integral part of the material, and shall not be surface applied. Bolt heads or similar attachments shall not rise above the traffic surface.

2.1.3.1 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.

2.1.3 Carpet

Carpet surfacing shall be factory installed using one full carpet square per panel. Carpet shall be 6,6 nylon continuous filament, loop pile, minimum 882 kg. per sq. meter, minimum density 333/10 kg. per sq. meter, and without cushion. Carpet shall conform to ASTM E 648 with a minimum average critical radiant flux of 0.25 watts per square centimeter. Static control shall be less than 2.0 kV at 20 percent relative humidity at 21 degrees C. Electrical resistance between the carpet tile and ground shall be 25 kilo-ohms to 100 megohms.

2.2 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 3 mm wide, and shall be flush with the floor surfacing.

2.3 Accessories

Registers, grilles, perforated panels, and plenum dividers shall be provided where indicated, and shall be the manufacturer's standard type. Registers, grilles, and 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. Registers and perforated panels shall be 25 percent open area and shall be equipped with adjustable dampers.

2.4 Resilient Base

Base shall be manufacturers standard rubber coved style (installed with high pressure laminate and carpet)]. Base shall be 100 mm high and a minimum 3 mm thick. Job Formed corners shall be furnished. Continuous rolls raher than 1200 mm lengths shall be used in order to give a smoothe finished appearance with a minimum of joints between corners. Color shall be as specified on the Finish Schedule in the architectural drawings.

2.5 Lifting Device

Each CTE module shall be provided with one floor panel lifting device standard with the floor manufacturer. A minimum of eight devices shall be furnished.

2.6 PANEL SUPPORT SYSTEM

2.6.1 Pedestals

Pedestals shall be of steel or aluminum or a combination thereof. Ferrous materials shall have a factory-applied corrosion-resistant finish. Pedestal base plates shall provide a minimum of 10,300 square millimeter of bearing surface and shall be a minimum of 3 mm thick. Pedestal shafts shall be threaded to permit height adjustment within a range of approximately 50 mm to permit overall floor adjustment within plus or minus 2.5 mm of the required elevation, and to permit leveling of the finished floor surface within 1.56 mm in 3000 mm in all directions. Locking devices shall be provided to positively lock the final pedestal vertical adjustments in place. Pedestal caps shall interlock with stringers to preclude tilting or rocking of the panels.

2.6.2 Stringers

Stringers shall be of rolled steel or extruded aluminum, and shall interlock with the pedestal heads to prevent lateral movement.

2.6.3 Underfloor Bracing

Special bracing to resist the effects of seismic or other forces shall be as shown on the approved detail drawings.

2.7 TESTS

Raised 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.

2.7.1 Load Tests

Floor panel, stringer, and pedestal testing shall be conducted in accordance with CISCA-01.

2.7.2 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 4.45 kN shall be imposed on the test assembly through a hard plastic caster 75 mm in diameter and 25 mm 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 on the finish schedule on the drawings.

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 16 and 32 degrees C, 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, and shall be secured to the structural floor with adhesive and steel expansion anchors.

3.1.3 Stringers

Stringers shall be interlocked with the pedestal caps to preclude lateral movement, and shall be spaced uniformly in parallel lines at the indicated

elevation.

3.1.4 Auxiliary Framing

Auxiliary framing or pedestals shall be provided around columns and other permanent construction, 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 2 mm measured with a 250 mm straightedge in all directions. Cut edges of steel and wood-core 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 Resilient Base

Base shall be provided at vertical wall intersections. Cracks and voids in walls and other vertical surfaces to receive base shall be filled with an approved filler. The base shall be applied after the floor system has been completely installed. Base shall be applied with adhesive in accordance with the manufacturer's recommendations.

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 21 to 24 degrees C. 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 25 kilo-ohms to 100 megohms, in accordance with the paragraph on carpet .

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 929 squared meters by tight, noncombustible bulkheads. All penetrations for piping and cables shall be sealed to maintain bulkhead properties.

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SECTION 10440

INTERIOR SIGNAGE

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	(1980) Designation System for Aluminum Finishes
AA PK-1	(1989) Registration Record of Aluminum Association Alloy Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot
AA SAA-46	(1978) Standards for Anodized Architectural Aluminum

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 605.2	(1992; Addenda Jan 1995) Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; Rev 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM C 1036	(1991) Flat Glass

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

1.2 GENERAL

Interior signage shall be of the sizes and types shown on the drawings, shall conform to the requirements specified herein, and shall be provided

at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Signs 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 2 years prior to bid opening.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Interior Signage; FIO.

Manufacturer's descriptive data, catalogs cuts, installation and cleaning instructions.

SD-04 Drawings

Interior Signage; FIO.

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 of each sign type shall be included.

SD-14 Samples

Interior Signage; GA.

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. Direction sign.

b. Door sign.

c. Building directory.

Two samples of manufacturer's standard color chips for each material requiring color selection.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area.

1.5 EXTRA STOCK

The Contractor shall provide 5% extra frames and extra stock of the following: 5% blank plaques of each color and size for sign types. 5% pressure-sensitive letters in each color and size for sign type . 5% changeable message strips for sign type.

PART 2 PRODUCTS

2.1 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 ALUMINUM ALLOY PRODUCTS

Aluminum extrusions shall be at least 3 mm thick, and aluminum plate or sheet shall be at least 1.3 mm thick. Extrusions shall conform to ASTM B 221; plate and sheet shall conform to ASTM B 209. Where anodic coatings are specified, alloy shall conform to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes shall be as shown and shall conform to AA SAA-46.

2.2.1 Anodic Coating

Anodized finish shall conform to AA DAF-45 as follows:

a. Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.010 mm or thicker.

b. Integral color anodized designation AA-M10-C22-A32, Architectural Class 0.010 to 0.018 mm .

c. Electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.010 to 0.018 mm .

2.2.2 Organic Coating

Organic coating shall conform to AAMA 605.2, with total dry film thickness not less than 0.030 mm.

2.3 VINYL SHEETING FOR GRAPHICS

Vinyl sheeting for graphics shall be a minimum 0.08 mm film thickness. Film shall include a precoated pressure sensitive adhesive backing.

2.4 ACRYLIC SHEET

Acrylic sheet for panels and components shall conform to ANSI Z97.1.

2.5 PLAQUE SIGNS

Plaque signs shall be a modular type signage system. Signs shall be fabricated of Type ES laminated thermosetting plastic suitable for engraving or acrylic plastic conforming to ANSI Z97.1.

2.5.1 Standard Modular Plaque Signs

Plaque signs shall consist of semi-glossmatte finish acrylic plastic, thickness and size as shown. Plaque signs shall be frameless with subsurface graphics. Corners of signs shall be squared.

2.5.2 Modular Changeable Message Strip Plaque Signs

Changeable message strip plaque signs shall consist of cast acrylic back laminated to semi-matte finish laminated thermosetting Type ES plastic face with message slots, as detailed, for insertion of changeable message strips. Thickness and size of signs shall be as shown on the drawings. Individual 1.6 mm thick message strips to permit removal, change, and reinsertion shall be provided as detailed. Corners of signs shall be squared.

2.5.3 Type of Mounting For Plaque Signs

Extruded aluminum brackets, in finish as shown, shall be furnished for hanging, projecting, and double-sided signs. Mounting for framed, hanging, and projecting signs shall be by holes and screws. Surface mounted signs shall be provided with concealed mounting screws.

2.6 GRAPHICS

2.6.1 Raised and Brailled Characters and Pictorial Symbols

Letters and numbers on signs which designate permanent rooms and spaces in handicapped-accessible buildings shall be raised 0.8 mm upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 16 mm high, but no higher than 50 mm. Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 152 mm minimum in height. Accessible facilities shall use the international symbols.

2.6.2 Graphics Application

Signage graphics shall conform to the following:

a. Pressure sensitive precision cut vinyl letters shall be provided. Edges and corners of finished letter forms and graphics shall be true and clean.

b. Message shall be applied to panel using the silkscreen process. Silkscreened images shall be executed with photo screens prepared from original art. No handcut screens will be accepted. Original art shall be defined as artwork that is a first generation reproduction of the specified art. Edges and corners shall be clean.

c. Message shall be acrylic letters 3 mm thick and chemically welded to 3.2 mm thick acrylic backup sheet.

d. Tactile characters and symbols shall be raised 0.8 mm minimum from the sign face. Signs shall be of one piece construction. Add-on characters are not acceptable.

2.6.3 Messages

See drawings and schedule for message content, Typeface, Type size, and color.

2.7 BUILDING DIRECTORIES

2.7.1 Building Directories

Building directories shall be provided with a silk screened directory listing consisting of the areas, offices and personnel located within the facility. The directory board shall be size as shown on the drawings. Colors shall be white letters and numbers silk screened on a black background. Message content shall be as determined by the Contracting Officer.

2.7.1.1 Header Lettering

Building or military unit name letters shall be upper case Helvetica Medium 19 mm high capital letter, centered. Service name letters shall be upper and lower case Helvetica Regular 13 mm capital letter, flush left. Building numbers shall be 13 mm high, flush left.

2.7.1.2 Floor Plan Graphics

Floor Plan shall be silk screened black copy, with room numbers, floor title, North arrow, and "YOU ARE HERE" indicator. Lettering shall be 19 mm upper case Helveica medium. Room numbers shall be 13 mm Helvetica regular. If rooms are too small for number, it shall be placed in close proximity with a leader line to indicate the location.

2.7.1.3 Directory Glazing

Glazing shall be in accordance with ASTM C 1036, Type 1, Class 1, Quality 3, minimum 3 mm clear acrylic sheet.

2.7.1.4 Fabrication

Extruded aluminum frames and trim shall be assembled with corners reinforced and mitered to a hairline fit, with no exposed fastners. Removable changeable directory panel shall consist of fiberboard back with wool felt covering backgrooved 6 mm on centers to receive flanged letters.

2.8 ANCHORS AND FASTENERS

Concealed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish. Anchorage system shall be of the type recommended by the manufacturer of the indicated substrate.

2.9 FABRICATION AND MANUFACTURE

2.9.1 Workmanship

Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

2.9.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed in accordance with approved manufacturer's instructions at locations shown on the drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. 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. 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. Mounting height shall be 1525 mm above the finish floor to the centerline of the sign. Mounting location for such signage shall be so that a person may approach within 75 mm 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.

3.1.1 Anchorage

Anchorage shall be in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. 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.

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DIVISION 10 - SPECIALTIES

SECTION 10500

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SECTION 10500

METAL LOCKERS

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	(1994)Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-dip Process
ASTM D 2092	(1986; R 1993) Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Locker Manufacturer's Catalog; FIO.

Manufacturer's catalog data identifying selected locker material, finish, components and assembly instructions.

SD-04 Drawings

Single Tier Lockers; FIO. Box Lockers; FIO.

Drawings showing locker sizes, type, quantity and layout. Also show method of installation, fillers, base, accessories and interior equipment.

SD-14 Samples

Color Chips; GA.

Provide minimum of three color chips, not less than 75 mm square, of each color indicated on the drawings.

1.3 GENERAL REQUIREMENTS

1.3.1 Quality Assurance

Provide metal lockers, necessary installation accessories, fittings and fasteners, as produced by a single manufacturer.

1.3.2 Job Conditions

Do not deliver metal lockers until building is enclosed and ready for locker installation. Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, handling, storage and installation.

1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication.

PART 2 PRODUCTS

2.1 LOCKER TYPES

Provide Type I, double tier lockers as indicated on the drawings. Provide locker finish color as indicated on the drawings.

2.2 FABRICATION

2.2.1 Material

Provide commercial quality, ASTM A 653/A 653M minimized spangle, galvanized steel sheet with not less than 2.75 mm zinc coating. Prepare surface sheet for painting in accordance with ASTM D 2092, Method A. Minimum uncoated sheet thickness shall be 1.6 mm for doors and door frames, 0.70 mm for side sheets and backs, and 1.0 mm for tops, bottoms, and shelves. Fasteners shall be manufacturer's standard zinc plated low round head slotless machine screws with hex nuts, truss fin head bolts and hex nuts or 4.76 mm steel rivets.

2.2.2 Construction

Lockers shall have flat, smooth metal surfaces without warp, dents or distortion. Assembled units shall be rigid and square. Bolt or rivet heads shall not be exposed on face of doors.

2.2.3 Finish

All parts are to be thoroughly cleaned before painting and given a bonding and rust-resisting phosphate coating to inhibit corrosion, followed by one coat of high-grade enamel sprayed on by electrostatic method. All locker parts shall be electrostatically sprayed inside and outside with the same color. Enamel to be baked on with the proper temperature-time relationship to insure thorough curing and a tough, durable finish. Hardware shall be zinc plated.

2.3 COMPONENTS

2.3.1 Door Frames

Uprights shall be not less than 1.6 mm steel. Cross members shall be not less than 1.6 mm. Exposed front frame edge shall be minimum 25.4 mm width, a 1-1/2 side frame depth and a 3.175 mm vertical door strike width on the hinge and latch side. Door frame shall be electrically welded together to assure rigid and square construction.

2.3.2 Doors

Doors shall be 1.6 mm cold rolled steel reinforced with right angle bends at top and bottom and with channel formation at the sides.

2.3.2.1 Latching Mechanism

The latching mechanism shall be quiet, positive, and operated by means of a spring actuated slide latch per manufacturer's design. The device shall be pre-locking, permitting latching the door channel by polyethelene or nylon guides that isolate the lock bar from metal-to-metal contact with the door.

2.3.2.2 Latching

There shall be three latching points on double-tier lockers. The lock bar travel is to be limited to contacting high density polyethelene, nylon or rubber cushioning devices located inside the lock bar.

2.3.2.3 Door Handle

The door handle shall be manufacturer's standard stainless steel or chrome plated, zinc alloy construction. Padlock eye for use with 7.14 mm diameter padlock shackles to be an integral part of handle and to be so located that extension of handle forms a padlock strike. Attachment to latch bar shall be tamperproof and concealed within the channel inside the door. The case shall be kick proof type, shielding the movable part and provide a padlock strike to prevent scratching and marring the door.

2.3.2.4 Door Silencers

The impact caused by the door closing shall be absorbed by an injected molded thermal plastic silencer securely fastened to each door.

2.3.2.5 Hinges

Hinges shall be a minimum of 50 mm high, 5-knuckle, full loop, tight pin style, securely welded to door frame and riveted to the inside of the door flange. Hinges shall be attached to the door with a minimum of two rivets. Fabricate knuckle hinges from not less than 2 mm thick steel sheet. A full height piano hinge may be provided if standard with the manufacturer. Provide double-tier lockers with two hinges.

2.3.2.6 Number Plates

Each locker shall have a polished aluminum number plate with black numerals not less than 9.5 mm high. Plate to be attached to front of each door with rivets. Provide consecutive numbers for rooms 147 and 149. The numbers shall be from 1 to 6.

2.3.2.7 Ventilation

Double-tier locker doors shall be provided with louvers at the top and bottom in groups of 6 louvers.

2.3.3 Interior Equipment

Double-tier lockers shall have a shelf fabricated from not less than 1.5 mm thick steel sheet approximately 230 mm below the top of the locker. Double -tier lockers shall have three single pronged wall hooks and one double

prong ceiling hook below shelf. Hooks to be steel, ball tip zinc plated, attached with two bolts per hook.

2.3.4 Accessories

Provide manufacturer's standard continuous slope hoods, fabricated from not less than 1.3 mm thick sheet steel, and secured to top of lockers with concealed fasteners. Accessory hoods shall be prefinished to match the locker color as indicated on the drawings.

PART 3 EXECUTION

3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's instructions. Align lockers horizontally and vertically so that installation shall be level and plumb with flush surfaces and rigid attachment to anchoring surfaces. Secure lockers to all and base with screws as indicated. Bolt adjacent lockers together. Install sloping hoods with concealed fasteners. Flush, hairline joints shall be provided at all abutting trim parts and at adjoining surfaces. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

3.2 NUMBERING SYSTEM

Install number plates on lockers consecutively.

3.3 QUALITY CONTROL

3.3 Repairing

Remove and replace damaged and unacceptable portions of the completed work with new.

3.4 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

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DIVISION 10 - SPECIALTIES

SECTION 10800

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2.2.5 Shower Curtain Rods (SCR)
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3.1 INSTALLATION
3.2 SCHEDULE

-- End of Section Table of Contents --

SECTION 10800

TOILET ACCESSORIES

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) Flat Glass

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2380	(Basic) Dispenser, Paper Towel
CID A-A-2398	(Rev B) Curtain, Shower and Window (Metric - SI)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation, submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Finishes; FIO. Accessory Items; FIO.

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, and operation instructions.

SD-14 Samples

Finishes; FIO]. Accessory Items; FIO.

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.

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, 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 [have oval heads] [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

2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

2.2.1 Grab Bar (GB)

Grab bar shall be 1.3 mm , 32 mm OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Concealed mounting flange shall have set screw mounting holes concealed on the lip of the flange. Grab bar shall have satin finish. Installed bars shall be capable of withstanding a 2.225 kN vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 38 mm.

2.2.2 Combination Paper Towel Dispenser/Waste Receptacle Units (PTDWR)

Dispenser/receptacle shall be recessed and shall have a capacity of 700 sheets of C-fold, single-fold, or quarter-fold towel. Waste receptacle shall be designed to be locked in unit and removable for service. Locking mechanism shall be tumbler key lock. Waste receptacle shall have a capacity of 68 L. Unit shall be fabricated of not less than 0.8 mm stainless steel welded construction with all exposed surfaces having a satin finish. Waste receptacle that accepts reusable liner standard for unit manufacturer shall be provided.

2.2.3 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 partition mounted, double access and surface mounted.

2.2.4 Shower Curtain (SC)

Shower curtain shall conform to CID A-A-2398, Style I, size to suit conditions.

2.2.5 Shower Curtain Rods (SCR)

Shower curtain rods shall be Type 304 stainless steel 32 mm OD by 1.24 mm minimum straight to meet installation conditions.

2.2.6 Soap Dispenser (SD)

Soap dispenser shall be lavatory mounted, liquid type consisting of a polyethylene tank with a minimum 0.94 L holding capacity and a 100 mm spout length.

2.2.7 Towel Pin (TP)

Towel pin shall have concealed wall fastenings, and a pin integral with or permanently fastened to wall flange. Maximum projection shall be 100 mm. Design shall be consistent with design of other accessory items.

2.2.8 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be Type III - recess mounted with two rolls of tissue stacked vertically. Cabinet shall be stainless steel, satin finish.

2.2.9 Toilet Seat Cover Dispenser (TSCD)

Toilet seat cover dispensers shall be stainless steel and be partition mounted. Dispenser shall have a minimum capacity of 500 seat covers.. Dual access dispensers shall have a minimum capacity of 500 seat covers per side. Combination seat cover dispenser, sanitary napkin disposal and/or toilet tissue dispenser shall meet the requirements of this paragraph, as well paragraph Sanitary Napkin and Tampon Disposer (SND) as applicable.

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 SCHEDULE

Room or Space	Accessories Required									
	GB	MG	PTDWR	SND	SC	SCR	SD	TP	TTD	TSCD
108	X	X	X	X			X		X	X
110	X	X	X				X		X	X
147		X	X		X	X	X	X	X	X
149		X	X	X	X	X	X	X	X	X

Accessories Required

Room or Space	GB	MG	PTDWR	SND	SC	SCR	SD	TP	TTD	TSCD
176		X	X	X			X		X	X
178		X	X				X		X	X

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DIVISION 12 - FURNISHINGS

SECTION 12520

WINDOW TREATMENT

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SECTION 12520

WINDOW TREATMENT

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.

FEDERAL SPECIFICATIONS (FS)

FS AA-V-00200	(Rev B) Venetian Blinds

NATIONAL FIRE PROTECTION (NFPA)

NFPA 701	(1996) Methods of Fire Test for Flame-Resistant Textiles and Films

1.2 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.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Window Treatments and Hardware; FIO.

Manufacturer's data composed of catalog cuts, brochures, product information, and maintenance instructions.

SD-04 Drawings

Window Treatments and Hardware; FIO.

Drawings showing fabrication and installation details. Drawings shall show layout and locations of track, direction of draw, mounting heights, and details.

SD-14 Samples

Window Treatments and Hardware; GA.

Three samples of each type and color of window treatment. Blind slats or louvers shall be 150 mm in length for each color. Track shall be 150 mm in length. Shade material shall be minimum 150 by 150 mm in size.

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 10 degrees C.

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 Vertical Blinds

Vertical blind units shall be capable of nominally 180 degree partial tilting operation and full stackback. The blinds shall be listed by the manufacturer as designed for heavy duty strength applications including heavy duty hardware. Vertical blinds shall be wall mounted with outside brackets as shown. Blinds shall be sill length. Outside mount type installation shall provide adequate overlap to control light and privacy.

2.1.1.1 Louvers

Solid vinyl louvers shall be fire resistant, UV stable, impact resistant, and shall not emit corrosive fumes in a fire. Louvers shall hang without a bottom chain. 50.8 mm (2 inch) louvers shall overlap not less than 6 mm and shall be dimensionally stable.

2.1.1.2 Carriers

Carriers shall be provided to support each louver. Carriers shall be of molded plastic and shall transverse on self-fabricated wheels for smooth, easy operation. The hook of the carrier shall have an automatic latch to permit easy installation and removing of the louver, and shall securely

lock the louver for tilting and traversing.

2.1.1.3 Headrail System

Headrail system shall be not less than 1.19 mm thickness and shall be made of anodized aluminum alloy or 0.635 mm thick phosphate treated steel with a baked on ivory gloss enamel paint finish. The headrail shall extend the full width of the blind and each end shall be closed with an end cap. One cap shall contain the traversing and tilting controls. The opposite cap shall house the pulley for the traversing cord.

2.1.1.4 Controls

Tilting control and traversing controls shall hang compactly at the right side of the blinds and shall reach within 1500 mm of the floor. The bead chain tilting control shall tilt all vanes simultaneously to any desired angle and hold them at that angle. The louvers shall traverse one way to the left. The traversing control cord shall be minimum 1.78 mm in diameter with a minimum breaking strength of 556 N. The cord shall be anchored to a lead carrier which shall be linked to all adjacent carriers. The louvers shall be traversed along the headrail by pulling one side of the looped cord. A weighted pulley shall be provided at the bottom of the cord.

2.1.1.5 Connectors and Spacers

The connector shall be flexible, smooth and flat to slide unhindered when carriers move independently of each other, and to nest compactly when carriers are stacking. The length of the links shall relate to the louver width in order to equally space the traversing louvers, to maintain uniform and adequate overlap of louvers, and to fully cover the width of the opening.

2.1.1.6 Intermediate Brackets

Intermediate installation brackets shall be furnished for blinds over 1575 mm wide.

2.2 COLOR

Color shall be as specified on the Finish Schedule in the architectural drawings.

PART 3 EXECUTION

3.1 WINDOW TREATMENT PLACEMENT SCHEDULE

Window covering shall be provided as follows: Instructors rooms 119 and 122 shall have 2-inch flat vertical vanes; 103, 127 Director of Operations, 104, 128 Commander, 111 Lounge, 113, 135 Instructors, 115, 121, 124, 137, 138 Flight Commanders, 140 Training Managers, and 175 Breat Room shall have 2" Sunscreen (Perforated-13% open)vertical vanes.

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.

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DIVISION 12 - FURNISHINGS

SECTION 12690

RECESSED FOOT GRID

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SECTION 12690

RECESSED FOOT GRID

PART 1 GENERAL

Furnish and install all items and accessories, anchors, bolts, screws, braces, etc. as may be required to complete the work.

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Data

Recessed Floor Grids; FIO.

Submit all maintenance data, including instructions for stain removal procedures.

SD-04 Drawings

Carpet Tread, Tread Rails and Frames; FIO.

Shop drawings showing sizes, details and method of construction, hardware materials, colors, method of installation and location of recessed floor grids and frames shall be submitted for approval.

SD-14 Samples

Carpet Tread; GA.Tread Rails; GA.

One 25 mm x 300 mm sample of the specified carpet tread shall be submitted to indicatepattern, color and style. One 25 mm x 300 mm sample of the tread rail shall be submitted indicating configuration and method of anchorage.

PART 2 PRODUCTS

2.1 Recessed Floor Grids

Recessed floor grids shall be 100% nylon carpet tread with color and pattern as indicated on the Finish Schedule in the architectural drawings. Carpet tread shall be mechanically secured in tread rails. All grid, tread rails and recessed framing sections when installed shall be designed to support a minimum uniform load of 297 Kg. per sq. meter. Drain pan application shall include a 16 gauge aluminum water proof pan with a 50 mm drain and strainer. Pan shall be securely attached to the bottom surface of the frame. Drains, traps and drain connections shall be furnished under

the plumbing contract.

2.1.1 Tread Rails

Tread rails shall be 6063 T-5 aluminim and shall be "I" shaped, spaced 38 mm on center running perpendicular to traffic flow. Tread rails shall be structurally joined to aluminum key lock bars, spaced 254 mm on center. Welding or bolting shall not be permitted.

2.1.2 Recessed Frame

Recessed frame shall be heavy gauge 6063 T-5 aluminum, factory pre-assembled with mitered corners complete with integral concrete strap anchors. Framing shall have a medium bronze durnodic finish.

PART 3 EXECUTION

3.1 INSTALLATION

The frame recess shall be verified prior to fabricating the tread rails and recessed framing. All Items shall be furnished complete with all accessories, anchors, bolts, screws, braces required to complete the work. Installations shall be in accordance with the manufacturers installation instructions in a level, accurate plane as specified on the drawings.

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SECTION 13080

SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT

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)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1996) Carbon Structural Steel
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(1994) Carbon and Alloy Steel Nuts
ASTM A 603	(1994) Zinc-Coated Steel Structural Wire Rope
ASTM A 653	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E 488	(1990) Strength of Anchors in Concrete and Masonry Elements
ASTM E 580	(1991) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01	(1994) Uniform Building Code (3 Vol.)

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-12	(1991; Appx E, 1993) Seismic Restraint Manual Guidelines for Mechanical Systems

UNDERWRITERS LABORATORIES (UL)

UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1991; Rev thru Mar 95) Incandescent Lighting Fixtures

1.2 SYSTEM DESCRIPTION

1.2.1 General

The requirements for seismic protection measures described in this section shall be applied to mechanical/electrical equipment and systems specified herein. Seismic protection requirements shall be in accordance with ICBO-01 using an importance factor of 1.0 and shall be provided in addition to any other requirements called for in other sections of these specifications. This facility shall be designed as being in seismic zone 4; no other zone values shall be used to establish bracing requirements. Lateral support against earthquake induced forces shall be accomplished by positive attachments without consideration of friction resulting from gravity loads.

1.2.2 Mechanical/Electrical Equipment

Mechanical/electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Boilers and furnaces	Storage Tanks for Water
Water Heaters	Steam, Water, and Gas Piping
Expansion Air Separator Tanks	Cable Trays
Water Chiller Units	
Control Panels	Air Handling Units
Pumps with Motors	
Light Fixtures	
Transformers	
Switchboards (Floor Mounted)	Storage Racks
Suspended Ceiling Assemblies	Ducts
Exhaust and Return Fans	
VAV Units	

1.2.3 Mechanical/Electrical Systems

The following mechanical and 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:

All Piping Inside the Building in Accordance With This Specification
Chilled Water Distribution Systems Outside of Buildings
All Water Supply Systems
Storm and Sanitary Sewer Systems

Condenser Water Piping Outside the Building

1.2.4 Equipment and Systems

The bracing for the following mechanical/electrical equipment and systems shall be developed by the Contractor in accordance with the requirements of this specification: FIO.

1.2.5 Exclusion

Seismic protection of piping for fire protection systems shall be installed as specified in Sections 15330 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION,

1.2.6 Pipes and Ducts Requiring No Special Seismic Restraints

Seismic restraints may be omitted from the following installations:

a. Gas piping less than 25 mm (1 inch) inside diameter.

b. Piping in boiler and mechanical equipment rooms less than 32 mm (1-1/4 inches) inside diameter.

c. All other piping less than 38 mm (1-1/2 inches) inside diameter.

d. Electrical conduit less than 64 mm (2-1/2 inches) inside diameter.

e. Rectangular air handling ducts less than 0.37 square meters (4 square feet) in cross sectional area.

f. Round air handling ducts less than 457 mm (18 inches) in diameter.

g. Piping suspended by individual hangers 300 mm or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.

h. Ducts suspended by hangers 300 mm or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions g. and h. all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced.

1.2.7 All Other Interior Piping, Conduit, and Ducts

Interior piping, conduit, and ducts not covered by paragraphs Exclusion or Pipes and Ducts Requiring No special Seismic Restraints shall be seismically protected in accordance with the provisions herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Bracing and Coupling; FIO. Lighting Fixtures in Buildings; FIO. Miscellaneous Equipment; FIO.

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.

SD-04 Drawings

Bracing and Coupling; FIO. Flexible Couplings or Joints; FIO. Resilient Vibration Isolation Devices; FIO. Lighting Fixtures in Buildings; FIO. Miscellaneous Equipment; FIO.

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-13 Certificates

Flexible Ball Joints; FIO.

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the requirements specified below:

2.1.1 Bolts and Nuts

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or ASTM A 307 for bolts and ASTM A 563 for nuts. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153.

2.1.2 Sway Bracing

Material used for members listed in this section, shall be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A 36.

b. Wire rope, ASTM A 603.

c. Tubes, ASTM A 500, Grade B.

d. Pipes, ASTM A 53, Type E or S, Grade B.

e. Light gauge angles, less than 6 mm thickness, ASTM A 653.

2.1.3 Flexible Couplings

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe specified in section 15400.

2.1.3.1 Flexible Ball Joints

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement.

2.1.3.2 Flexible Mechanical Joints

a. Mechanical couplings for steel or cast iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets. Underground bolts shall be high-strength type as specified above.

2.1.4 Lighting Fixture Supports

Fixture supports shall be malleable iron. Lighting fixtures and supports shall conform to UL 1570 or UL 1571 as applicable.

PART 3 EXECUTION

3.1 BRACING AND COUPLING

Bracing and coupling shall conform to the arrangements shown. Provisions of this paragraph apply to all piping within a 1.5 m line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. No trapeze-type hanger shall be secured with less than two 13 mm (1/2 inch) bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

3.2 BUILDING DRIFT

Sway braces for a run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Joints capable of accommodating seismic displacements shall be provided where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. For threaded piping, swing joints shall be provided. For piping with manufactured ball joints the seismic drift shall be 0.015 meters per meter of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers larger than 90 mm (3-1/2 inches) in diameter. Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets or no-hub fittings may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to comply with these requirements.

3.3.2 Underground Piping

Underground piping and 100 mm (4 inch) or larger conduit, except heat distribution system, shall have flexible couplings installed where the piping enters the building. The couplings shall accommodate 75 mm (3 inch) mm of relative movement between the pipe and the building in any direction. Additional flexible couplings shall be provided where shown on the drawings.

3.4 PIPE SLEEVES

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve.

3.5 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 100 mm apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 ANCHOR BOLTS

3.6.1 Cast-In-Place

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except as specified below. Two nuts shall be provided on each bolt. Anchor bolts shall conform to the following tabulation for the various equipment weights and specified seismic zone or the manufacturer's installation recommendations, whichever is the most stringent, unless otherwise shown on the drawings. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

3.6.2 Minimum Bolt Sizes, Cast-In-Place Anchor Bolts

Maximum Equipment Weight (Kg)	Minimum Bolt Sizes (mm)* Zone 4
225	13
450	13
2250	13
4500	13
9000	13
13500	16
22500	22
45000	**

*Based on four bolts per item, a minimum embedment of 12 bolt diameters, a minimum bolt spacing of 16 bolt diameters and a minimum edge distance of 12 bolt diameters. Equivalent total cross-sectional area shall be used when more than four bolts per item are provided. Anchor bolts shall conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt.

**Equipment weighing more than 22,500 kg in Zones 3 and 4 shall have at least six bolts per item.

3.6.3 Expansion or Chemically Bonded Anchors

Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. The expansion anchor size shall be not less than that required in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

3.6.3.1 General Testing

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than 24 hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

3.6.3.2 Torque Wrench Testing

Torque wrench testing shall be done on not less than 50 percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for 9 mm sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

3.6.3.3 Pullout Testing

Expansion and chemically bonded anchors shall be tested by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least 5 percent of the anchors, but not less than three per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to 1 times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

3.7 RESILIENT VIBRATION ISOLATION DEVICES

Selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS except that an equipment weight equal to five times the actual equipment weight shall be used.

3.7.1 Resilient and Spring-Type Vibration Devices

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 15 mm.

3.7.2 Multidirectional Seismic Snubbers

Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor- or slab-mounted equipment. These snubbers shall provide 6 mm free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.8 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

3.8.1 Transverse Sway Bracing

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those given in the tabulation below as modified for each seismic zone. All runs shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

3.8.2 Maximum Span for Transverse Sway Braces in Seismic Zone 4

Pipe Diameter	Std. Wgt. Steel Pipe - 40S		Ex. Strong Steel Pipe - 80S		Copper Tube Type L	
(mm)	*L(m)	**F(kN)	*L(m)	**F(kN)	*L(m)	**F(kN)
25	6.7	0.30	6.7	0.4	3.4	0.08
40	7.6	0.60	7.9	0.8	3.7	0.16
50	8.8	1.0	9.1	1.3	4.3	0.30
65	9.8	1.7	10.0	2.1	4.8	0.50
80	10.4	2.5	10.7	3.2	5.2	0.70
90	11.0	3.3	11.6	4.1	5.5	1.0
100	11.9	4.3	12.2	5.3	5.8	1.3
125	12.5	6.4	13.4	8.5	6.1	2.1
150	13.7	9.4	14.0	12.2	6.7	3.3
200	14.9	16.6	16.5	22.9	7.9	6.9
250	16.5	27.1	18.0	34.1	8.5	11.7
300	17.7	38.1	18.6	46.0	9.4	17.6

*L = Maximum span between lateral supports multiplied by 1.1 for Zone 3, 1.25 for Zone 2A, 1.2 for Zone 2B, or 1.35 for Zone 1.

**F = Horizontal force on the brace multiplied by 0.8 for Zone 3, 0.5 for Zone 2A, 0.6 for Zone 2B, or 0.3 for Zone 1.

NOTE: Bracing shall consist of at least one vertical angle 50 x 50 mm x 16 gauge and one diagonal angle of the same size.

3.8.3 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided at 12 m intervals except when the location of sway braces is shown on the drawings for the particular piping system. All runs shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.8.4 Vertical Runs

Vertical runs of piping shall be braced at not more than 3 m vertical intervals. For tubing, bracing shall be provided at no more than 1.2 m spacing. Vertical braces shall be above the center of gravity of the span being braced. All sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.8.5 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

3.8.6 Maximum Length for Anchor Braces

Type	Size (millimeters)	Maximum Length* (meters)	Allowable Loads* (kilonewtons)
Angles	38 x 38 x 6	1.5	25.5
	50 x 50 x 6	2.0	34.5
	64 x 38 x 6	2.5	43.5
	75 x 64 x 6	2.5	48.0
	75 x 75 x 6	3.0	53.0
Rods	91	1.0	16.5
	22	1.0	22.0
Flat Bars	38 x 6	0.4	14.0
	50 x 6	0.4	18.0
	50 x 10	0.5	28.5
Pipes (40s)	25	2.0	18.0
	32	2.8	24.5
	40	3.2	29.5
	50	4.0	39.5

*Based on the slenderness ratio of l/r = 200 and ASTM A 36 steel, where l is the length of the brace and r is the least radius of gyration of the brace.

3.8.7 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.8.8 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 13 mm (1/2 inch) diameter.

3.9 SWAY BRACES FOR DUCTS

3.9.1 Braced Ducts

Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA-12, including Appendix E, using Seismic Hazard Level A and connection level 3.

3.9.2 Unbraced Ducts

Hangers for unbraced ducts shall be positively attached to the duct within 50 mm of the top of the duct with a minimum of two #10 sheet metal screws. Unbraced ducts shall be installed with a 150 mm minimum clearance to vertical ceiling hanger wires.

3.10 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe.

3.11 EQUIPMENT SWAY BRACING

3.11.1 Suspended Equipment

Equipment sway bracing shall be provided for items supported from overhead floor or roof structures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 13 mm (1/2 inch) bolts. Braces shall conform to paragraph Maximum Length for Anchor Braces. Sufficient braces shall be provided for equipment to resist a horizontal force equal to 1.50 times the weight of equipment without exceeding safe working stress of bracing components. Details of equipment bracing shall be submitted for approval. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.11.2 Floor or Pad Mounted Equipment

3.11.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

3.11.2.2 Overturning Resistance

The ratio of the height of the equipment (measured from the base to the center of gravity of the equipment) to the minimum distance between anchor bolts shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. If this ratio is greater than 1.67 the bolt values in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts shall not be used and calculations shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

3.12 MISCELLANEOUS EQUIPMENT

3.12.1 Rigidly Mounted Equipment

The following specific items of equipment to be furnished under this contract shall be constructed and assembled to withstand a horizontal lateral force of 0.30 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

Rigidly Mounted Equipment

Boilers
Chillers
Air-Handling Units

Transformers
Switch Boards
Free Standing Electric
Motors

3.13 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

3.13.1 Pendant Fixtures

Loop and hook or swivel hanger assemblies for pendant fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendant-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

3.13.2 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system and shall be fastened thereto at each corner of the fixture with bolts or approved clips; or shall be provided with fixture support wires attached to the building structural members using two wires for individual fixtures, attached to opposite corners, and one wire per unit of continuous row mounted fixtures. Each wire support shall be capable of supporting four times the weight of the fixture. Recessed lighting fixtures not over 25 kg in weight and suspended or pendant-hung fixtures not over 10 kg in weight may be supported by and attached directly to the ceiling system runners by a positive attachment such as screws or bolts, number and size as required by design seismic zone.

3.13.3 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 100 mm boxes, 75 mm plaster rings, and fixture studs.

3.13.4 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system. Fixture support devices for attaching to suspended ceilings shall be a locking-type scissor clamp or a full loop band that will securely attach to the ceiling support. Fixtures attached to underside of a structural slab shall be properly anchored to the slab at each corner of the fixture.

3.13.5 Wall-Mounted Emergency Light Unit

Each wall-mounted emergency light unit shall be secured to remain in place during a seismic disturbance.

3.13.6 Lateral Force

Light fixture bracing shall be designed to resist a lateral force of1.50 times the fixture weight.

3.14 SUSPENDED CEILING ASSEMBLIES

The structural members of ceiling support systems, used primarily to support acoustical tile panels or acoustical panel lay-in tiles, with or without lighting fixtures, ceiling-mounted air terminals, and ceiling-mounted services, shall conform to the following:

3.14.1 Design Loads

The main runners and cross-runners and their splices and intersection connections shall be designed for two times the design load or ultimate axial tension or compression (minimum 550 N (120 pounds).) The connections at the splices and intersections shall be of a mechanical interlocking type that cannot easily be disengaged. Ceiling structural systems shall be designed to withstand required vertical load as well as a lateral force of 30 percent of the ceiling weight. The ceiling weight shall include all lighting fixtures and other equipment that are laterally supported by the ceiling and shall be not less than 200 Pa (4.0 psf). Exception: Ceiling areas of 13 square meters or less surrounded by walls that connect directly to the structure above will be exempt from the lateral-load standards of this specification.

3.14.2 Installation Requirements

Installation requirements shall be in accordance with ASTM E 580 except as follows:

3.14.2.1 Vertical Support

Hanger wires supporting a maximum tributary ceiling area of 1.5 square meters shall be a minimum of 10 gauge in diameter. The size of wires supporting a tributary ceiling area greater than 1.5 square meters shall be substantiated by design calculations. Hanger attachment devices used in ceiling systems not exceeding 200 Pa shall be capable of supporting a minimum allowable load of 1.3 kN (300 pounds). Hanger attachment devices used in ceiling systems exceeding 200 Pa shall be capable of supporting the design load and shall be substantiated by design calculations. If hangers must be splayed more than one horizontal to six vertical, the resulting horizontal force shall be offset by bracing or counter-splaying, and substantiated by design calculations.

3.14.2.2 Lateral Support

In lieu of the design criteria stated above, where ceiling loads do not exceed 200 Pa, lateral support for the ceiling system may be provided by four galvanized wires of minimum No. 12 gauge, as indicated in ASTM E 580, paragraph 4.4.6.

3.14.3 Lighting Fixture and Air Diffuser Supports

Lighting fixture and air diffuser supports shall be designed and installed to meet the requirements of equipment supports in the preceding paragraphs of this specification with the following exceptions:

a. Recessed lighting fixtures not over 25 kg in weight and suspended and pendent-hung fixtures not over 10 kg in weight may be supported and attached directly to the ceiling system runners by a positive attachment such as screws or bolts.

b. Air diffusers that weigh not more than 10 kg and that receive no tributary loading from ductwork may be positively attached to and supported by the ceiling runners.

-- End of Section --

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13814

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SECTION 13814

BUILDING PREPARATION FOR ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

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 C12.1	(1988) Code for Electricity Metering

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-18	(1971; Int. Supple 19.5-1972; Errata 1974) Fluid Meters, Their Theory and Application

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(1993) Instrument Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems

1.2 GENERAL REQUIREMENTS

1.2.1 Preparation of Building for Interface

The Contractor shall provide all services, materials, and equipment necessary to prepare the building for interface to the existing. This specification section shall pertain to only those devices that solely serve the EMCS. HVAC direct digital control (DDC) devices that perform a dual function for both the DDC system and EMCS shall be specified in Section 15951 Direct Digital Control for HVAC.

1.2.2 Environmental Conditions

All equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered at the installed location.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Performance; FIO.

Six copies of the hardware and maintenance data, in manual format, bound in hardback, loose-leaf binders, within 30 days after completing the site testing. The contents of each manual shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and 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, to be submitted after completion of the site test, shall include all modifications made during installation, checkout, and acceptance.

Hardware data, shall describe all equipment provided, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Electrical schematics and layout drawings.

d. Alignment and calibration procedures.

e. Manufacturer's repair parts list indicating sources of supply, and National Stock Number when obtainable from the manufacturer.

f. Interface definition.

The maintenance data, shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

SD-04 Drawings

Equipment and Material; FIO.

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. Drawings shall contain complete wiring, routing, and schematic diagrams. Drawings shall show proposed layout and installation of all equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-08 Statements

Test Plan; FIO.

Six copies of test plan and test procedure. Six copies of test report that documents the test results, in booklet form. Test plan documents for the test, 120 days prior to the test. The test plan shall define all the tests required to ensure that the equipment meets technical and performance specifications. The test plan shall define milestones for the test exercises and shall identify the capabilities and functions to be tested.

Test Procedure; FIO.

Test procedure documents, 60 days prior to the test. Test procedures shall be developed from the test plans and design documentation. The procedures

shall consist of detailed instructions for test setup, execution, and evaluation of test results. The procedures shall explain and shall detail, step by step, actions and expected results to demonstrate the requirements of this specification and the methods for simulating the necessary conditions of operation to demonstrate performance of the equipment. All test equipment to be used shall be furnished by the Contractor.

SD-09 Reports

Site Testing; FIO.

Test report, within 15 days after completion of the test. The test report shall be used to document results of the test.

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. Units of the same type of equipment shall be products of a single manufacturer.

2.2 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors shall be Type 12, or as shown. Equipment installed outdoors shall be housed in a Type 4 enclosure, unless otherwise shown.

2.3 NAMEPLATES

Laminated plastic nameplates shall be provided for all equipment furnished. Each nameplate shall identify the function, such as "mixed air controller" or "cold deck temperature sensor." Laminated plastic shall be 1/8 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches, with minimum 1/4 inch high engraved block lettering. Nameplates for devices smaller than 1 by 3 inches shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the equipment.

2.4 INSTRUMENTATION AND CONTROL (I&C) DIAGRAMS

Framed mylar drawings in laminated plastic shall be provided. Drawings shall show complete I&C diagrams for all equipment furnished and interfaces to all existing equipment, at each respective equipment location. 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 manually shall be prepared in typed form, framed as specified for the I&C diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The instructions shall be posted after completion of the Contractor's site testing. Provide a mylar reproducible of each I&C diagram in addition to the posted copy.

2.5 DATA TERMINAL CABINET (DTC)

Data terminal cabinet shall be provided for each mechanical room as an interface to the data environment (DE) instrumentation and controls. No

instrumentation and control devices shall be located within the DTC.

2.5.1 Enclosure

The DTC shall be a separate metallic enclosure. The DTC shall be sized to accommodate the number of functions required by the control and monitoring devices as shown plus 25 percent expansion for each type of function provided.

2.5.2 Groupings

The DTC shall be divided into analog and digital groupings, each with separate sensor and control signal wiring raceways.

2.5.3 Terminal Strips

The DTC shall be provided with double sided screw type terminal strips. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. The other side shall be used to connect the DTC to the existing FID or MUX. Terminal strips shall have individual terminal identification numbers.

2.5.4 Power

A 120-Vac, 15-A, 60 Hz duplex outlet shall be provided within 6 feet of each DTC.

2.6 INSTRUMENTATION AND CONTROL

2.6.1 Temperature Instruments

2.6.1.1 Resistor Temperature Detector (RTD)

RTDs shall be platinum with an accuracy of plus or minus 0.1 percent at 32 degrees F and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter specified and mounted integrally, unless otherwise shown.

2.6.1.2 Resistor Temperature Detector (RTD) Transmitters

The RTD transmitter shall be selected to match the resistance range of the platinum RTD. The transmitter shall produce a linear 4 to 20 mAdc output corresponding to the required temperature span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments unless the RTD element is integral to the transmitter and system calibration is provided.

2.6.1.3 Temperature Switches

Temperature switches shall have a repetitive accuracy of plus or minus 1 percent of the operating ranges shown. Switch actuation shall be adjustable over the operating temperature range. The switch shall have a snap-action Form C contact rated for the application.

2.6.1.4 Thermowells

Thermowells shall be monel, brass, or copper for use in copper water lines, wrought iron for measuring flue gases, and series 300 stainless steel for all other applications. The thermowell shall include a connection box,

sized to accommodate the temperature transmitter.

2.6.1.5 Instrument Shelters

Instrument shelters shall be fabricated from wood and painted white. Shelters shall have louvered sides, double tops, and slotted bottoms.

2.6.2 Relative Humidity Sensors

Relative humidity sensors shall use nonsaturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. Sensors shall have a range of 20 to 80 percent, with an accuracy of plus or minus 5 percent of full scale. A transmitter located at the sensor shall be provided to convert the sensor output to a linear 4 to 20 mAdc output corresponding to the required humidity span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

2.6.3 Pressure Instruments

2.6.3.1 Pressure Transducers

Pressure transducers shall withstand up to 150 percent of rated pressure, with an accuracy of plus or minus 1 percent of full scale. The sensing element shall be either capsule, diaphragm, bellows, bourdon tube, or solid state. A transmitter located at the transducer shall be provided to convert the sensing element output to a linear 4 to 20 mAdc output corresponding to the required pressure span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

2.6.3.2 Pressure Switches

Pressure switches shall have a repetitive accuracy of plus or minus 5 percent of their operating range and shall withstand up to 150 percent of rated pressure. Sensors shall be diaphragm or bourdon tube. Switch actuation shall be adjustable over the operating pressure range. Switch shall have a snap-action Form C contact rated for the application. Gauge pressure switches shall have an adjustable differential setting.

2.6.4 Flow Instruments

2.6.4.1 Orifice Plates

Orifice plates shall be made of a series 300 stainless steel sheet of 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate shall be flat within 0.001 inch. The orifice surface roughness shall not exceed 20 microinches. The thickness of the cylindrical face of the orifice shall not exceed 1/50 of the pipe inside diameter or 1/8 of the orifice diameter, whichever is smaller. The upstream edge of the orifice shall be square and sharp.

2.6.4.2 Flow Nozzles

Flow nozzles shall be made of series 300 stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form shall be elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that distortion of the nozzle throat from strains caused by the pipeline temperature and

pressure, flange bolting, or other methods of installing the nozzle in the pipeline shall not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

2.6.4.3 Venturi Tubes

Venturi tubes shall be made of cast-iron or cast-steel and shall have an accuracy of plus or minus 1 percent of full flow. The throat section shall be lined with series 300 stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a 50 microinch finish, including the short curvature leading from the converging entrance section into the throat.

2.6.4.4 Annular Pitot Tubes

Annular pitot tubes shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of series 300 stainless steel. Sensor shall have an accuracy of plus of minus 2 percent of full flow.

2.6.4.5 Turbine Meters

Turbine meters shall be series 300 stainless steel with an accuracy of plus or minus 1 percent from 30 to 100 percent of actual flow. Turbine flowmeters shall consist of two components, a turbine and an electronic transmitter. The turbine shall measure the flow, and the electronic transmitter shall produce a linear analog output of 4 to 20 mAdc corresponding to the required flow span. The transmitter shall include offset and span adjustments.

2.6.4.6 Vortex Shedding Flowmeters

The vortex flowmeter shall produce an analog 4 to 20 mAdc signal that is linearly proportional to the volumetric flow rate. The accuracy shall be within plus or minus 0.8 percent of the actual flow. The electronic transmitter for the vortex flowmeter shall allow either internal or external mounting, within 50 feet of the flow sensor. The flowmeter body shall be made of series 300 stainless steel.

2.6.4.7 Flow Switches

Flow switches shall have a repetitive accuracy of plus or minus 1 percent of its operating range. Switch actuation shall be adjustable over the operating flow range. The switch shall have a snap-action Form C contact rated for the application.

2.6.5 Electric Power Instruments

2.6.5.1 Potential Transformers

Potential transformers shall conform to IEEE C57.13.

2.6.5.2 Current Transformers

Current transformers shall conform to IEEE C57.13.

2.6.5.3 Meters and Meter Sockets

Meters in Watthour and meter sockets shall conform to ANSI C12.1. Meters shall have pulse initiators for remote monitoring of watthour consumption. Pulse initiator shall consist of Form C contacts with a current rating not to exceed 2 amperes and voltage not to exceed 500 volts, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations.

2.6.5.4 Meters with Demand Register

Meters in Watthour with demand register and meter sockets shall conform to ANSI C12.1. Meters shall have pulse initiators for remote monitoring of watthour consumption and instantaneous demand. Pulse initiators shall consist of Form C contacts with a current rating not to exceed 2 amperes and voltage not to exceed 500 volts, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations.

2.6.5.5 Transducers

Transducers in Watthour shall have an accuracy of plus or minus 0.25 percent for outputs from full lag to full lead power factor. Input ranges for transducers shall be selectable without requiring the changing of current or potential transformers. The output shall be 4 to 20 mAdc.

2.6.5.6 Current Sensing Relays

Current sensing relays shall be of a design that provides a normally-open (NO) single-pole, single-throw (SPST) contact rated at a minimum of 50 volts peak and one-half ampere or 25 VA, noninductive. Current sensing relays shall be single unit construction with provisions for firm mounting. They have a single hole for passage of current carrying conductors and sized for operation at a nominal 50 percent of current rating of sensed device. The Contractor shall use multiple turns of sensed leads for higher rate loads. Voltage isolation shall be for a minimum of 600 volts.

2.6.6 Detectors

Leak detectors shall use electrodes mounted at slab level with either a minimum time delay of 0.5 seconds or a minimum built-in vertical adjustment of 1/8 ich to prevent activation due to high humidity. Detector shall have a contact rating of 1.0 amp resistive or 200 ma inductive at 28 VDC.

2.6.6.1 Leak Detector Panel

Leak detector panel shall indicate which detector is in the alarmed state. A laminated diagram showing the location of the detectors and a legend to coordinate the panel alarm indicator and detector locations shall be posted next to the panel. Lettering shall be a minimum of 1/8 inch high. Panel indicator shall be manually reset type.

2.6.7 Output Devices

2.6.7.1 Control Relays

Control relay contacts shall be rated for the application, with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient

suppression devices to limit transients to 150 percent of rated coil voltage.

2.6.7.2 Time Delay Relays

Time delay relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Delayed contact opening or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of plus or minus 2 percent of setting.

2.6.7.3 Latching Relays

Latching relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

2.6.7.4 Reed Relays

Reed relays shall be encapsulated in a container housed in a plastic, epoxy, or metal case. Contacts shall be rated for the application. Operating and release times shall be 1 millisecond or less. Relays shall be rated for a minimum life of 10 million mechanical operations and shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

2.6.7.5 Contactors

Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contacts shall be double-break silver-to-silver type protected by arcing contacts where necessary. Number of contacts and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

2.6.7.6 Solid State Relays

Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 volts root mean square or greater at 60 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least minus 20 to plus 140 degrees F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release times shall be 1 millisecond or less. Transients shall be limited to 150 percent of control voltage. Solid state relays shall not be used on inductive loads which are switched on-off.

2.6.7.7 Electric Solenoid Operated Pneumatic (EP) Valve

EP valves shall have three port operations: common, normally open, and normally closed. EP valves shall have an outer cast aluminum body with internal parts constructed of brass, bronze, or stainless steel. The air

connection shall be a 3/8 inch NPT threaded connection. EP valves shall be rated for 50 psig when used in control system operation at 25 psig or less, or rated at 150 psig when used in control system operation from 25 to 100 psig. EP coils shall be equipped with transient suppression to limit transients to 150 percent of rated voltage. EP valve operation shall be rated for a minimum of 220 degrees F.

2.6.7.8 Single Input Control Point Adjustment (CPA) Controller

Single input CPA controllers shall permit changing of control points remotely by varying the CPA port value. CPA shall be plus or minus 10 percent of primary sensor span. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band), and shall be field selectable for direct or reverse action. Pneumatic units provided shall be constructed to withstand a maximum pressure of 25 psig. All controller inputs and outputs shall be provided with internal or external gauges or meters for calibration of input and output signals.

2.6.7.9 Dual Input Controller

Dual input controllers shall permit changing of control points remotely by varying the second port input value. Controllers shall operate from electronic or pneumatic sensors as shown. Controllers shall be complete with adjustable setpoint, adjustable gain (proportional band), adjustable authority, and shall be field selectable for direct or reverse action. Authority effect of secondary sensor on setpoint shall be adjustable from 33 to 100 percent of primary sensor span. Pneumatic units provided shall be constructed to withstand a maximum pressure of 25 psig. All controller inputs and outputs shall be provided with internal or external gauges or meters for calibration of input and output signals.

2.6.7.10 Electric to Pneumatic (EP) Transducers

EP transducers shall be matched to the analog output signals from the existing FID or MUX and have linearly proportional pneumatic output compatible with the pneumatic control loop to be interfaced. The EP transducer shall have pressure calibration adjustments and shall withstand pressures at least 150 percent of the maximum range. The pneumatic output shall be linearly proportional within 1 percent of the electric input. Transducers shall have offset and span adjustment capabilities. EP transducers shall be rated for zero to 140 degrees F continuous operation. The body shall be cast aluminum with internal parts constructed of brass, bronze, or stainless steel.

2.6.7.11 Motorized Potentiometers

Motorized potentiometers shall be reversible brushless alnico or samarium cobalt permanent magnet dc motors with rotary potentiometers coupled to the motor or gearhead output shaft. Motors shall be 7/8 inch diameter or larger, with a minimum rated life of 1,000 operating hours or 200,000 revolutions. Motors shall accept signals for clockwise rotation and counterclockwise rotation. With no signal present, the motor shall remain stationary. Rotary potentiometers shall be wirewound or conductive plastic, single or multiturn potentiometers with a minimum rated life of 200,000 revolutions. Potentiometers shall have a maximum resistance tolerance of plus or minus 10 percent and a maximum linearity tolerance of plus or minus 1 percent. Potentiometers shall be rated for a minimum of 1 watt at 125 degrees F. Motorized potentiometers shall be housed in

enclosures meeting both NEMA Type 4 and NEMA Type 13 ratings, and shall be suitable for operation at ambient temperatures of 35 to 120 degrees F.

2.6.7.12 Potentiometer to Current Transducers

Potentiometer to current transducers shall have an accuracy of plus or minus 0.1 percent of span for 3-wire potentiometer inputs between 100 and 10,000 ohms full scale. Potentiometer transducers shall provide continuous span adjustments between 75 and 100 percent of the input range and continuous zero offset adjustment between 0 and 10 percent of the input range. Potentiometer transducers shall provide excitation current to the potentiometer and shall drive a 4 to 20 mAdc output signal, with 500 volts peak to peak isolation between input and output terminals. Potentiometer transducers shall be suitable for operation at ambient temperatures of minus 20 to 175 degrees F.

2.6.8 Position Sensors

2.6.8.1 End (Limit) Switches

Limit switches shall be of the sealed or enclosed type as required for the application. Contacts shall be snap-action Form C rated for the application.

2.6.8.2 Potentiometers

Potentiometers may be either rotary or linear, depending on the application of each position indicator. Position potentiometers shall have a linearity of plus or minus 5 percent and shall indicate position on a percent open basis.

2.6.9 Key Operated Switches

Hand-off-automatic (HOA), off-automatic, and all similar-use switches shall be key operated with all switches keyed alike. All switches shall be rated for a minimum of 600 Vac, 5-A, and shall be mounted in an enclosure as specified or shown. An auxiliary set of contacts rated for at least 120 Vac, 1 ampere shall be provided with each switch.

2.7 WIRE AND CABLE

The Contractor shall provide all wire and cable from the sensors and control devices in the DE to the DTCs.

2.7.1 Control Wiring

2.7.1.1 Digital Functions

Control wiring for digital functions shall be No. 18 AWG minimum with 600-volt insulation. Multiconductor wire shall have an outer jacket of Polyvinyl Chloride (PVC).

2.7.1.2 Analog Functions

Control wiring for analog functions shall be No. 18 AWG minimum with 600-volt insulation, twisted and shielded, 2-, 3-, or 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.7.2 Sensor Wiring

Sensor wiring shall be No. 20 AWG minimum twisted and shielded, 2-, 3-, 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.7.3 Class 2 Low Energy Conductors

The conductor types and sizes specified for digital and analog functions shall take precedence over any requirements for Class 2 low energy remote control and signal circuit conductors specified elsewhere.

2.8 RACEWAY SYSTEMS

Raceway systems from the sensors and control devices in the DE to the DTCs shall be provided by the Contractor.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

The Contractor shall install all components and appurtenances in accordance with the manufacturer's instructions and as shown or specified. All necessary interconnections, services, and adjustments required to prepare the building for interface to an EMCS shall be furnished. All wiring, including low voltage wiring, shall be installed in metallic raceways. All other electrical work shall be in accordance with Section 16415 and as shown. Instrumentation grounding as necessary to preclude ground loops and noise from adversely affecting equipment operations shall be installed.

3.2 I/O SUMMARY TABLES

I/O Summary Tables shall be used in conjunction with the drawings to identify the hardware required for each building and system.

3.3 EQUIPMENT INSTALLATION

3.3.1 Temperature Instruments

3.3.1.1 Resistor Temperature Detector (RTD)

When the RTD is installed in pipes or is susceptible to corrosion and vibration, the RTD shall be installed in a thermowell. RTDs which are attached to surfaces shall be clamped or bonded in place. The surface shall be thoroughly cleaned, degreased, and after RTD installation, shall be insulated from ambient temperature effects. RTDs used for space temperature sensing shall include a housing suitable for wall mounting. RTDs used for OA sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to minimize building effects. RTD assemblies shall be readily accessible and installed in a manner as to allow easy replacement.

3.3.1.2 Temperature Switches

Temperature switches shall be installed as specified for RTDs. Temperature switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected in accordance with NEMA ICS 1.

3.3.2 Relative Humidity Sensors

Relative humidity sensors shall have air guards when installed in air flows of more than 50 feet per minute across the sensor element.

3.3.3 Pressure Instruments

3.3.3.1 Pressure Sensors

Pressure sensors (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure sensors shall have valves for isolation, venting, and taps for calibration. Pressure sensors shall be verified by calibration. Differential pressure sensors shall have nulling valves.

3.3.3.2 Pressure Switches

Pressure switches (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure switches in water and steam lines shall have valves for isolation, venting, and taps for calibration. Pressure switches shall be adjusted to the proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection. Differential pressure switches shall have nulling valves. Switch contact ratings and duty shall be selected in accordance with NEMA ICS 1.

3.3.4 Flow Instruments

3.3.4.1 Flowmeters

Flowmeters shall be installed in accordance with ASME-18.

3.3.4.2 Orifice Plates

Orifice plates shall be located in horizontal pipe runs. For liquid measurement, the orifice plate flanges shall be installed so that the pressure taps are in the horizontal plane with the centerline of the pipe. For gas measurement, the orifice plate flanges shall be installed so that the pressure taps are 45 degrees or more above the horizontal plane with the centerline of the pipe. For steam measurement, eccentric orifice plate flanges shall be installed so that the pressure taps are 45 degrees below, or in the horizontal plane with the centerline of the pipe. Orifice plates shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be as close to the orifice plates as possible. For gas measurement the required differential pressure transmitter shall be physically installed above the orifice taps. For steam, the required differential pressure transmitter shall be physically installed a minimum of 8 inches below the taps. For liquid, the differential pressure transmitter shall be installed below the orifice tops.

3.3.4.3 Flow Nozzles

Flow nozzles shall be installed in horizontal pipe runs with flanges installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be installed as close to the flow nozzle as possible.

3.3.4.4 Venturi Tubes

Venturi tubes shall be installed in horizontal pipe runs. Venturi tubes shall be installed so that the pressure tap is in the horizontal plane with the centerline of the pipe. Venturi tubes shall be installed for ease of accessibility for periodic maintenance.

3.3.4.5 Annular Pitot Tubes

Annular pitot tubes shall be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports shall extend diametrically across the entire pipe. Annular pitot tubes shall not be used wherever the flow is pulsating or where pipe vibration exists.

3.3.4.6 Turbine Meters

Turbine meters shall be installed so that the sensor is located in the center of the fluid flow pipe on the main axis.

3.3.4.7 Vortex Shedding Flowmeters

The flowmeter shall be installed with its top above the pipeline in horizontal installations. The direction of flow shall be upward in vertical installations. The flowmeter shall be aligned to the direction of the flow, and shall be rigidly mounted and vibration free.

3.3.4.8 Flow Switches

Flow switches shall be installed in such a manner as to minimize any disturbance in the flow of fluid while maintaining reliable operation of the switch.

3.3.5 Electric Power Devices

3.3.5.1 Potential Transformers

Potential transformers shall be installed in new cabinets as shown.

3.3.5.2 Current Transformers

Current transformers shall be installed in new cabinets as shown.

3.3.5.3 Meters

Watthour meters shall be installed in new cabinets as shown.

3.3.5.4 Demand Meters

Watthour demand meters shall be installed in new cabinets as shown.

3.3.5.5 Transducers

Watthour transducers shall be installed in new cabinets as shown.

3.3.5.6 Current Sensing Relays

Relays shall be installed in new cabinets as shown.

3.3.6 Floor Mounted Leak Detectors

Detectors shall be mounted per manufacturer's recommendation.

3.3.7 Output Devices

3.3.7.1 Relays and Contactors

Relays and contactors shall be installed in new cabinets.

3.3.7.2 Electric Solenoid Operated Pneumatic Valve (EP)

EP valves shall be installed in new cabinets.

3.3.7.3 Controllers

Controllers shall be installed in new control cabinets or as shown.

3.3.7.4 Electric to Pneumatic (EP) Transducers

EP transducers shall be installed in new cabinets.

3.3.8 Position Sensors

3.3.8.1 End (Limit) Switch

Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation.

3.3.8.2 Potentiometers

Potentiometer type and mounting shall be properly suited for the application to provide reliable operation.

3.3.9 Instrument Shelters

Instrument shelters shall be installed with the bottom 4 feet above the supporting surface, using legs, and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented facing north.

3.3.10 Enclosures

All enclosure penetrations shall be from the bottom and shall be sealed to preclude entry of water using a silicone rubber sealant.

3.4 SITE TESTING

Site testing and adjustment of all equipment shall be performed in accordance with approved test procedures. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. Test reports shall be submitted as specified.

END OF SECTION

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15250

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SECTION 15250
THERMAL INSULATION FOR MECHANICAL SYSTEMS

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	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580	(1995a) Stainless and Heat-Resisting Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1990) Mineral Fiber Thermal Insulating Cement
ASTM C 449	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1985; R 1990) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 612	(1993) 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) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 871	(1995) Test Methods for Chemical Analysis of Thermal Insulation Materials for

	Leachable Chloride, Fluoride, Silicate, and Sodium Ions
ASTM C 916	(1985; Rev 1990) Adhesives for Duct Thermal Insulation
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM C 921	(1989 R; 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1989; R 1994) Specification for faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM D 3278	(1989) Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) 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

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA-01	(1993) National Commercial & Industrial Insulation Standards

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. 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 rating no higher than 75 and a smoke developed rating no higher than 150. The outside surface of insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed ratings shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material that shall be used in the actual construction. Jackets shall comply with the flame spread and smoke developed ratings of 25/50 as determined by 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 "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Thermal Insulation Materials; FIO.

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-01 plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment which is/are 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.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

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 by the Contractor. 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 meetASTM 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

Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming toASTM C 916, Type I. 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.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging adhesives shall be nonflammable and fire-resistant and shall have flame spread and smoke developed ratings of 25/50 when measured in accordance with ASTM E 84. Adhesives shall be either the Class 1 or Class 2 type as defined here. Class 1 adhesive shall be pigmented [white] [red] 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; or for bonding lagging cloth to thermal insulation. Class 2 adhesive shall be pigmented white and be suitable 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 with a low flash point (flash point less than minus 25 degrees F when tested in accordance with ASTM D 3278) 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 omit 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.

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. Fibrous glass cloth and tape; 20 x 20 maximum size mesh. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces per square yard.

2.1.7 Staples

Outward clinching type monel.

2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, 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.

2.1.8.1 White Vapor Retarder ASJ (All Service Jacket)

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 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 Pittsburg 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. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

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 not exceed 0.05 perm and 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. The flash point of the compound shall not be less than 80 degrees F and shall be determined in accordance with ASTM D 3278. All other application and service properties shall be in accordance with ASTM C 647.

2.1.10 Wire

Soft annealed ASTM A 580 Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be as follows:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to Plus 60 degrees F shall be as follows:

2.2.1.1 Cellular Glass

ASTM C 552, Type II, and Type III.

2.2.1.2 Flexible Cellular Insulation

ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

2.2.1.3 Phenolic Insulation

ASTM C 1126, Type III. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.2.2 Aboveground Hot Pipeline

For aboveground hot pipeline above 60 degrees F insulation the following requirements shall be met.

2.2.2.1 Mineral Fiber

ASTM C 547, Class 1 or Class 2 as required for the operating temperature range.

2.2.2.2 Calcium Silicate

ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

2.2.2.3 Cellular Glass

ASTM C 552, Type II and Type III.

2.2.2.4 Flexible Cellular Insulation

ASTM C 534, Type I or II to 200 degrees F service.

2.2.2.5 Phenolic Insulation

ASTM C 1126 Type III to 250 F service. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.2.3 Below ground Pipeline Insulation

ASTM C 552, Type II.

2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be as follows:

2.3.1 Rigid Mineral Fiber

ASTM C 612, Class 1.

2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I, Class B-2.

2.3.3 Cellular Glass

ASTM C 552, Type I.

2.3.4 Phenolic Foam

ASTM C 1126 Type II. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.3.5 Flexible Cellular

ASTM C 534 Type II.

2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be as follows:

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 Cellular Insulation

ASTM C 534, Type II.

2.4.1.3 Phenolic Foam

ASTM C 1126 Type II. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

2.4.2 Hot Equipment Insulation

For temperatures above 60 degrees F.

2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type 2, 3, 4 or 5 as required for temperature encountered to 1800 degrees F.

2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type 1, 2, 3, 4, 5, 6, or 7 as required for temperature encountered to 1200 degrees F.

2.4.2.3 Calcium Silicate

ASTM C 533, Type I, indoors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200 degrees F.

2.4.2.4 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.4.2.5 Flexible Cellular Insulation

ASTM C 534, Type II, to 200 degrees F.

2.4.2.6 Phenolic Foam

ASTM C 1126 Type II to 250 degrees F. A maximum allowable leachable chloride content shall comply withASTM C 795 when tested in accordance with ASTM C 871.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

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 aforementioned 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-01 standard plates except where modified herein or on the drawings.

3.1.2 Fire stopping

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 07270 FIRE STOPPING.

3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.1.4 Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible 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.

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, unless stated otherwise, on all pipes, ducts, or equipment, which operate at or below 60 F and at or above 80 F.

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. Unions in pipe above 60 degrees F.

e. Strainers in pipe above 60 degrees F.

f. Check valves in pipe above 60 degrees F.

g. Air chambers.

3.2.1.2 Pipes Passing Through Sleeves

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.

g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulations for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

h. 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 5 ft level shall be protected.

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 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 cellular insulation shall conform to ASTM C 921, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Pipes Passing Through Walls

a. 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. 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.

b. For domestic cold water pipes requiring 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 pipe and wall penetration. 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.

3.2.1.5 Flexible Cellular Pipe Insulation

Flexible 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.

3.2.2 Aboveground Cold Pipelines

The following shall be included for aboveground cold pipelines minus 30 degrees to plus 60 degrees F:

a. Domestic cold and chilled drinking water.

b. Make-up water.

c. Horizontal and vertical portions of interior roof drains.

d. Refrigerant suction lines.

e. Chilled water.

f. Dual temperature water, i.e. HVAC hot/chilled water.

g. Air conditioner condensate drains.

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
Brine System Cryogenics (-30 to 0 deg F)	CG		2.5	2.5	3.0	3.0	3.5
	FC		1.5	1.5	1.5	1.75	1.75
	PF		1.0	1.0	1.5	1.5	1.5
Brine System Cryogenics 0 to 34 deg F)	CG		2.0	2.0	2.0	2.5	3.0
	FC		1.0	1.0	1.25	1.25	1.5
	PF		1.0	1.0	1.0	1.0	1.5
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
	PF		1.0	1.0	1.0	1.0	1.0]
Chilled water supply & return & dual temp 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
	PF	0.5	1.0	1.0	1.0	1.0	1.0
Cold domestic water, above and below ceilings	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	3/8	3/8	3/8	3/8	3/8	3/8
	PF	3/8	3/8	3/8	3/8	3/8	3/8
Exposed lavatory drains exposed domestic water piping &	FC	0.5	0.5	0.5	0.5	3/4	3/4
	MF	0.5	1.0	1.0	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
drains to areas for handicap personnel							
Horizontal roof drain leaders (including underside of roof drain fitting)	FC		1.0	1.5	1.5	1.5	1.5
	PF		0.5	0.5	0.5	0.5	0.5
	CG		1.5	1.5	1.5	1.5	1.5
Vertical roof drain leaders	FC		1.0	1.0	1.5	1.5	1.5
	PF		0.5	0.5	0.5	0.5	0.5
	CG		1.5	1.5	1.5	1.5	1.5]
Air conditioning condensate drain located inside building	FC		3/8	0.5	0.5	N/A	N/A
	PF		3/8	3/8	3/8	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:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular

3.2.2.2 Jacket for Fibrous, Cellular Glass, and Phenolic 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 5 ft level will be protected.

3.2.2.3 Insulation for Straight Runs (Fibrous, Cellular Glass and Phenolic Foam)

a. Insulation shall be applied to the pipe with joints tightly butted. The ends of fibrous insulation shall be sealed off with

vapor retarder coating at intervals not to exceed 15 feet.

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.

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 have ends thoroughly coated with a vapor retarder coating not less than 6 inches from each flange, union, valve, anchor, or fitting in all directions.

b. Precut, preformed insulation for placement over fittings, flanges, unions, valves, anchors, and mechanical couplings shall be used. Precut, preformed insulation shall exhibit the same properties as the adjoining pipe insulation. 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 should be overlapped 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Elbows insulated using segments shall not have less than 3 segments per 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 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.

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. Flexible connections at pumps and other equipment shall be insulated with « inch flexible cellular insulation, unless otherwise indicated.

f. 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 premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same thickness as adjoining pipe insulation and the insulation shall be protected with one coat of vapor retarder coating under the PVC cover. 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

For hot pipelines above 60 degrees F the following shall be included:

a. Domestic hot water.

b. Steam.

c. Condensate.

d. Hot water heating.

e. Heated oil.

f. Water defrost lines in refrigerated rooms.

3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible 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 (200 F max)	CG	1.5	1.5	1.5	1.5	1.5	1.5
	FC	0.5	1.0	1.0	1.5	1.5	1.5
	PF	0.5	1.0	1.0	1.0	1.0	1.0
	MF	0.5	1.0	1.0	1.5	1.5	1.5
Compressed Air discharge steam & condensate return (201-250 F)	CG		1.5	2.0	2.0	2.0	2.5
	PF		1.0	1.0	1.0	1.0	1.5
	MF		1.5	1.5	2.0	2.0	2.5
	CS		1.5	2.0	2.5	2.5	2.5
Heating hot water, supply & return (250 F max)	CG	1.5	1.5	2.0	2.0	2.0	2.5
	PF	0.5	1.0	1.0	1.0	1.0	1.5
	MF	0.5	1.5	1.5	2.0	2.5	3.0
	CS	1.0	1.5	2.0	2.5	2.5	2.5]
Medium Temp Hot water & steam (251 - 350 F)	CG	1.5	2.5	3.0	3.5	3.5	4.0
	MF	1.5	2.0	2.5	2.5	3.0	3.5
	CS	1.5	2.5	2.5	3.5	3.5	4.5]
High Temp Hot water & steam (351 - 500 F)	CG	2.0	3.5	4.0	4.5	5.0	5.5
	MF	1.5	3.0	3.5	4.0	4.0	4.5
	CS	2.0	3.5	4.0	4.5	5.0	5.5]

When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

3.2.3.2 Jacket for Insulated Pipe

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 wrapping a strip of jacket material around the pipe and be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

f. Install flexible cellular pipe insulation 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 must 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. The run of the line pipe insulation shall have the ends brought up to the item.

b. Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 2 inches or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 3 inch size shall be premolded. Insulation for elbows 3 inch size and larger shall be either premolded or segmented. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.

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 Class 1 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 shall be applied. PVC jacketing requires no factory applied jacket beneath it. Flexible cellular insulation exposed to weather shall be treated in accordance with paragraph FLEXIBLE 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 an emulsion type weatherproof mastic 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 used with PVC lagging and adhesive welded moisture tight.

3.2.4.3 PVC Lagging

PVC lagging shall be ultraviolet resistant and adhesive welded vapor tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

3.2.5 Below ground Pipe Insulation

The following shall be included:

a. Heated oil.

b. Domestic hot water.

c. Heating hot water.

d. Dual temperature water.

e. Steam.

f. Condensate.

3.2.5.1 Type of Insulation

Below ground pipe shall be insulated with 3 inch cellular glass insulation set in a coat of bedding compound as recommended by the manufacturer.

3.2.5.2 Installation of Below ground Pipe Insulation

a. Bore surfaces of the insulation shall be coated with a thin coat of gypsum cement of a type recommended by the insulation manufacturer. Coating thickness shall be sufficient to fill surface cells of insulation. Mastic type materials shall not be permitted for this coating.

b. Insulation applied to the pipe shall have joints tightly butted and bedded together with bedding compound as recommended by the manufacturer. Butt joints shall be staggered.

c. Stainless steel bands, 3/4 inch wide by 0.020 inch thick shall be used to secure insulation in place. A minimum of two bands per section of insulation shall be applied. As an alternate, fiberglass reinforced tape may be used to secure insulation on piping up to 12 inches in diameter. A minimum of two bands per section of insulation shall be applied.

d. Insulation shall terminate at anchor blocks but shall be continuous through sleeves and manholes.

e. At point of entry to buildings, underground insulation shall be terminated 2 inches inside the wall or floor, shall butt tightly against the aboveground insulation and the butt joint shall be sealed with vapor retarder coating.

f. Provision for expansion and contraction shall be made in accordance with the insulation manufacturer's recommendations.

g. Flanges, couplings, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated sections of insulation of the same material and thickness as the adjoining pipe insulation. Insulation sections shall be secured in place with wire, bore surfaces coated, and joints sealed as specified.

h. Insulation, including fittings, shall be finished with three coats of asphaltic mastic, with 10 by 10 glass mesh reinforcing fabric embedded between coats. Fabric shall be overlapped a minimum of 2 inches at joints. Total film thickness shall be a minimum of 3/16 inch. As an alternate, a prefabricated bituminous laminated jacket, reinforced with 10 by 10-glass fiber mesh, shall be applied to the insulation. Jacketing material and application procedures shall match manufacturer's written instructions.

i. At termination points, other than building entrances, the mastic and cloth or tape shall cover the ends of insulation and extend 2 inches along the bare pipe.

3.3 DUCT INSULATION INSTALLATION

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces unless otherwise shown. 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

Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (mm)

Cold Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38
Warm Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38

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
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation and vapor retarder for cold air duct below 60 degrees F: Ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

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.

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 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 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. Fibrous and cellular glass insulation on concealed duct shall be provided with a factory-applied Type I 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.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval 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 18 inch centers and not more than 18 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners 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 under the overlap with Class 2 adhesive and stapled on 4 inch centers. Staples 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. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with Class 2 adhesive and staples. Staples and 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. 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.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

d. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of the same material as the vapor retarder jacket. The strip shall be secured with Class 2 adhesive and stapled. Staples and seams shall be sealed with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. 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.

h. Oval and round ducts, flexible type, shall be insulated with

factory Type I jacket insulation with minimum density of 3/4 pcf attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide stripe on 12 inch centers.

3.3.3 Insulation for Warm Air Duct

For warm air ducts above 60 degrees F, ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts.

d. Flexible runouts (field insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil casings.

h. Fresh air intake ducts.

i. Filter boxes.

j. Mixing boxes.

k. Supply fans.

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 on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with Class 1 adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 3/4 pcf with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Class 1 adhesive finish where indicated to be used shall be accomplished by applying two coats of Class 1 adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners

shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured with Class 2 adhesive under the lap and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed and flashed with a Class 1 adhesive. Two coats of Class 1 adhesive coating shall be applied with glass cloth embedded between coats. The total coating shall have a dry film thickness of approximately 1/16 inch and shall overlap the adjoining insulation and uninsulated surface 2 inches.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by applying Class 2 adhesive around the entire perimeter

of the duct in 6 inch wide stripe on 12 inch center. Joints shall be sealed with a 4 inch wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.

3.3.4 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.

3.3.5 Insulation for Evaporative Cooling Duct

Evaporative cooling supply duct located in spaces not evaporatively cooled, shall be insulated. Material and installation requirements shall be as specified for duct insulation for warm air duct.

3.3.6 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.

3.3.6.1 Round Duct

Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 3 inches and secured with bands located at circumferential laps and at not more than 12 inch intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with caulking to prevent moisture penetration. Where jacketing abuts an uninsulated surface, joints shall be sealed with caulking.

3.3.6.2 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

3.3.6.3 Rectangular Ducts

Two coats of weatherproof mastic shall be applied to the entire surface with a layer of glass cloth embedded between coats. Glass cloth overlaps at joints and adjoining surfaces shall be not less than 2 inches. Each coat of weatherproof mastic shall be 1/16 inch minimum thickness. The top of the exterior duct work shall be built up with insulation in such a manner as to ensure a positive drain of any rain water which may appear. The minimum pitch of the built up section shall be in accordance with the recommendation of the manufacturer of the vapor retarder/weatherproof mastic. Care should be taken in the construction of the built up section so that no low areas appear; this shall ensure no "pooling" of water on the vapor retarder which leads to premature degradation of the retarder and subsequent deterioration of the insulation.

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.

d. Cold water storage tanks.

e. Water softeners.

f. Duct mounted coils.

g. Cold and chilled water pumps.

h. Pneumatic water tanks.

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: 2 inch thick cellular glass, 1-1/2 inch thick flexible cellular, or 1 inch thick phenolic foam.

b. Equipment Handling Media Between 0 degree F and 34 degrees F: 3-1/2 inch thick cellular glass, 2-1/2 inch flexible cellular, or 1-1/2 inch thick phenolic foam.

c. Equipment Handling Media Between minus 30 degrees F and 1 degree F: 4 inch thick cellular glass 3 inch thick flexible cellular, or 1-1/2 inch thick phenolic foam.

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 cellular insulation. The box shall conform to the requirements of MICA-01 plate No. 49 when using flexible 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 cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer. Mineral fiber insulation joints shall be filled with finishing cement.

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 inches 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 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.

3.4.3 Insulation for Hot Equipment

Hot equipment above 60 degrees F: Insulation shall be furnished on equipment handling media above 60 degrees F including the following:

a. Hot water generators.

b. Water heaters.

c. Pumps handling media above 130 degrees F.

d. Hot water storage tanks.

e. Air separation tanks.

f. Boiler flue gas connection from boiler to stack (if inside).

g. Induced draft fans.

h. Condensate receivers.

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 thicknesses shall be as follows:

a. Equipment handling steam to 15 psig or other media to 250 degrees F: 2 inch thick rigid mineral fiber, 2 inch thick flexible mineral fiber, 2 inch thick calcium silicate, 1.5 inch cellular glass, 1.5 inch thick phenolic foam, to 200 degrees F 1.0 inch Flexible Cellular.

b. Equipment handling steam to 200 psig or other media to 400 degrees F: 3 inch thick rigid mineral fiber, 3 inch) thick flexible mineral fiber, 3 inch thick calcium silicate, 3 inch thick cellular glass.

c. Equipment handling media to 600 degrees F: 5 inch thick rigid mineral fiber, 6 inch thick flexible mineral fiber, 6 inch thick calcium silicate, 6 inch thick cellular glass.

d. Equipment handling media above 600 degrees F: Insulate with a thickness of material required to limit the external temperature of the insulation to 120 degrees F except that diesel engine exhaust piping and mufflers shall be covered with 6 inch thick material suitable for 1200 degrees F service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

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, thus 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 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.

d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

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 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 inches washers or shall be securely banded or wired in place on 12 inch (maximum) centers.

g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of Class I 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 that 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 -- End of Section --

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SECTION 15330

WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

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 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 135	(1993) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1990) Carbon Steel Tract Bolts and Nuts
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 795	(1995) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM D 3309	(1994) Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems
ASTM F 442	(1994) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
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) Wrought Copper and Copper Alloy

	Solder Joint Pressure Fittings
ASME B18.2.1	(1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015	(1993) Double Check Backflow Prevention Assembly

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-10062JU	(1992) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1990) 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	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1995; Supple I; Supple II; Supple III) Approval Guide

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1994) Installation of Sprinkler Systems
NFPA 231C	(1995) Rack Storage of Materials

NFPA 1963	(1993) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL-01	(1996) Building Materials Directory
UL-04	(1996; Supple) Fire Protection Equipment Directory
UL 668	(1989; Rev Feb 1994) Hose Valves For Fire Protection Service

1.2 GENERAL REQUIREMENTS

Wet pipe sprinkler system shall be provided in all 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. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation.

1.2.1 Hydraulic Design

The system shall be hydraulically designed to discharge a minimum density of 4.07 L/min/M^2 (0.1 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.

1.2.1.1 Hose Demand

An allowance for exterior hose streams of minimum 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 50 psi, and a flow of 746 gpm at a residual pressure of 40 psi. 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, and 100 for existing underground piping.

1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed limits specified in NFPA 13 for light, ordinary, extra hazard occupancy.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Load Calculations for Sizing Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations shall be provided for sizing of sway bracing.

Sprinkler System Equipment; FIO.

Manufacturer's Catalog Data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; FIO.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; FIO.

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.

SD-04 Drawings

Sprinkler System Shop Drawings; FIO.

Detail drawings conforming to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views which establish 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 Drawings; FIO.

As-built drawings, no later than 14 working days after completion of the Final Tests. The sprinkler system shop drawings shall be updated to reflect as-built conditions after work is completed and shall be on reproducible full-size mylar film.

SD-06 Instructions

Test Procedures; FIO.

Proposed test procedures for piping hydrostatic test, testing of alarms, at least 14 days prior to the start of related testing.

SD-07 Schedules

Preliminary Tests; FIO.

A schedule of preliminary tests, at least 14 days prior to the proposed start of the tests.

Final Test; FIO.

Upon successful completion of tests specified under PRELIMINARY TESTS, written notification shall be given to the Contracting Officer of the date for the final acceptance test. 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.

SD-08 Statements

Installer Qualifications; FIO.

Qualifications of the sprinkler installer.

Submittal Preparer's Qualifications; FIO.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and

hydraulic calculations.

SD-13 Certificates

Contractor's Material & Test Certificates; FIO.

Certificates, as specified in NFPA 13, shall be completed and signed by the Contractor's Representative performing required tests for both underground and aboveground piping.

SD-19 Operation and Maintenance Manuals

Sprinkler System; FIO.

Manuals shall be in loose-leaf binder format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. The manuals shall list routine maintenance procedures possible breakdowns, and repairs, and troubleshooting guide. This shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

1.4 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software specifically designed for fire protection system design. Software which uses k-factors for typical branch lines is not acceptable. Calculations shall be taken back to the water supply source unless water supply data is otherwise indicated. Calculations shall substantiate that the design area indicated is the hydraulically most demanding. 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.

1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

The sprinkler system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer 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.

1.6 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed sprinkler system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

1.7 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. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

1.8 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

2.1.1 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.

2.1.2 Requirements for Fire Protection Service

Equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL-04 or approved by Factory Mutual and listed in FM P7825. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL-04 or FM P7825.

2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

2.2 UNDERGROUND PIPING SYSTEMS

2.2.1 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 of 175 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 02660 WATER LINES.

2.2.2 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.

2.3 ABOVEGROUND PIPING SYSTEMS

Aboveground piping shall be steel.

2.3.1 Steel Piping System

2.3.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black or galvanized as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53, 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.

2.3.1.2 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. Steel press fittings shall be approved for fire protection systems. 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 which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

2.3.1.3 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. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, 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.

2.3.1.4 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. Bolts shall be squarehead conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

2.3.2 Copper Tube Systems

2.3.2.1 Copper Tube

Copper tube shall conform to ASTM B 88, Types L and M.

2.3.2.2 Copper Fittings

Cast copper alloy pressure fittings shall conform to ASME B16.18 and wrought copper and bronze pressure fittings shall conform to ASME B16.22.

2.3.3 Valves

2.3.3.1 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-01 or FM P7825.

2.3.3.2 Check Valve

Check valve 2 inches and larger shall be listed inUL-01 or FM P7825. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plates, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

2.3.3.3 Hose Valve

Valve shall comply with UL 668 and shall have a minimum rating of 300 psi. Valve shall be non-rising stem, all bronze, 90 degree angle type, with 2-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valve shall be provided with 2-1/2 inch to 1-1/2 inch reducer. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished brass.

2.4 ALARM CHECK VALVE ASSEMBLY

Assembly shall include an alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, main drain, and other components as required for a fully operational system.

2.5 WATER MOTOR ALARM ASSEMBLY

Assembly shall include a body housing, impeller or pelton wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch galvanized piping shall be provided between the housing and the alarm check valve. Drain piping from the body housing shall be minimum 1 inch galvanized and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and outside surfaces.

2.6 ALARM INITIATING AND SUPERVISORY DEVICES

2.6.1 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 include two SPDT (Form C) contacts, 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.

2.6.2 Sprinkler Pressure (Waterflow) Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 1/2 inch NPT male pipe thread. The switch shall have a maximum service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

2.6.3 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.

2.7 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting 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.

2.8 SPRINKLERS

Sprinklers shall be used in accordance with their listed spacing limitations. Temperature classification shall be as indicated. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters shall have temperature classification in accordance with NFPA 13.

2.8.1 Upright Sprinkler

Upright sprinkler shall be brass and shall have a nominal 1/2 inch or 17/32 inch orifice.

2.8.2 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, quick-response type with nominal 1/2 inch. Pendent sprinklers shall have a polished chrome finish.

2.8.3 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 1/2 inch orifice. Sidewall sprinkler shall have a brass finish. Sidewall sprinkler shall be the quick-response type.

2.9 ACCESSORIES

2.9.1 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.

2.9.2 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.

2.9.3 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.

2.9.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located as indicated.

2.9.5 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.

2.10 FIRE HOSE REEL ASSEMBLY

Assembly shall be Class I and include nozzle, fire hose, reel, 1-1/2 inch valve, and bracket suitable for wall mounting. The assembly shall be semi-automatic type complete with Underwriters clip which permits controlled one-man operation whereby control valve can be opened, hose unreeled and clip released by pulling on hose. Valve shall be non-rising stem, all bronze, angle type with 1-1/2 inch American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Reel shall be of steel construction with red enamel finish and shall be equipped with 100 feet of 1-1/2 inch rubber lined fire hose. Nozzle shall be of the industrial combination fog-straight stream type with shutoff. Components of the assembly shall be listed in UL-04.

2.11 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 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.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Installation of in-rack sprinklers shall comply with applicable provisions of NFPA 231C.

3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be run straight and bear evenly on hangers and supports.

3.2.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection of the piping system shall be provided in accordance with NFPA 13 and Appendix A, with the exception that the "Earthquake Zones" map of Appendix A shall not apply to this project. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required in NFPA 13 for protection of piping against damage from earthquakes. Branch lines shall be equipped with sway braces at the end sprinkler head and at intervals not exceeding 30 ft. Protection of piping from earthquake damage is not required.

3.2.2 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.

3.2.3 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.

3.2.4 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.

3.2.4.1 Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 6 inches from ceiling grid.

3.2.5 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.

3.2.6 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 byNFPA 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 and fittings shall be from the same manufacturer.

3.2.7 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.

3.2.8 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 pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve. In penetrations which 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 which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

3.2.9 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.

3.2.10 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.

3.2.11 Drains

Main drain piping shall be provided to discharge [at a safe point outside the building] [at the location indicated]. Auxiliary drains shall be provided as required by NFPA 13 except that drain valves shall be used where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line.

3.2.12 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.

3.2.13 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.

3.3 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 02660 WATER LINES.

3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02221 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

3.5 ELECTRICAL WORK

Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 16721 FIRE DETECTION AND ALARM SYSTEM. Wiring color code shall remain uniform throughout the system.

3.6 FIELD PAINTING AND FINISHING

Field painting and finishing are specified in Section 09900 PAINTING, GENERAL.

3.7 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.

3.7.1 Underground Piping

3.7.1.1 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 that the calculated maximum water demand rate of the system.

3.7.1.2 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.

3.7.2 Aboveground Piping

3.7.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance withNFPA 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.

3.7.3 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.

3.7.4 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.

3.8 FINAL ACCEPTANCE TEST

A technician employed by the installing Contractor shall be present for the final tests 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.

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SECTION 15400

PLUMBING, GENERAL PURPOSE

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) 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 Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 74	(1996) Cast Iron Soil Pipe and Fittings
ASTM A 105	(1996) Forgings, Carbon Steel, for Piping Components
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 516	(1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 518	(1992) Corrosion-Resistant High-Silicon Iron Castings
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

ASTM A 888	(1994) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1995b) Solder Metal
ASTM B 42	(1993) Seamless Copper Pipe, Standard Sizes
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 111	(1993) Copper and Copper-Alloy Seamless Condenser Tubes and Ferule Stock
ASTM B 152	(1994) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 306	(1996) Copper Drainage Tube (DWV)
ASTM B 584	(1996) 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	(1992) Making Capillary Joints by Soldering of Copper and Copper-Alloy Tube and Fittings
ASTM C 564	(1995) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM D 638	(1996) Tensile Properties of Plastics
ASTM D 1785	(1994) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1996) Rubber Products in Automotive Applications
ASTM D 2235	(1993a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2464	(1994) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1994a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1994) Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D 2661	(1995) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1993; R 1995) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2822	(1991) Asphalt Roof Cement
ASTM D 2855	(1993) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3138	(1993) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1989; R 1995) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1993) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1	(1995) ASTM Thermometers
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM F 439	(1993a) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	(1995) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442	(1994) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1993a) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 891	(1993a) Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core

ASTM F 1290	(1993) Electrofusion Joining Polyolefin Pipe and Fittings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(1991) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1988) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.14.1	(1975; R 1990) Backwater Valves
ASME A112.18.1M	(1996) Plumbing Fixture Fittings
ASME A112.19.1M	(1994) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	(1995; Errata) Vitreous China Plumbing Fixtures
ASME A112.19.4M	(1994) Porcelain Enameled Formed Steel Plumbing Fixtures
ASME A112.21.1M	(1991) Floor Drains
ASME A112.21.2M	(1983) Roof Drains
ASME A112.36.2M	(1991) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.12	(1991) 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) 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; Errata) 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	(1988) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1995) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1995) Controls and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1002	(1964; Rev thru Apr 1986) Water Closet Flush Tank Ball Cocks
ASSE 1003	(1964; Rev thru Oct 1993; Errata Dec 1993) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1993) 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	(1971; Rev thru Oct 1993) Reduced Pressure Principle Backflow Preventers

ASSE 1018	(1977; Rev Jan 1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1037	(1986; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures/F

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-01	(1995) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C105	(1993) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1987) Grooved and Shouldered Joints
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA D100	(1984; D100a) Welded Steel Tanks for Water Storage
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	(1995) 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
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-238	(Rev B) Seat, Water Closet
CID A-A-240	(Basic) Shower Head, Ball Joint
CID A-A-50012	(Basic) Garbage Disposal Machine, Commercial

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA-02	(1995) Copper Tube Handbook

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1992; Errata Jun 1993) Accessible and Usable Buildings and Facilities

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCCHR-01	(1993) Manual of Cross-Connection Control

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(1996) Steel Pipe Line 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	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-welding Ends for General Service
MSS SP-73	(1991) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1987; R 1992) 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-01	(1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1992) National Fuel Gas Code
NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF Std 5	(1992) Hot Water Generating Equipment
NSF Std 14	(1965; Rev Nov 1990) Plastics Piping Components and Related Materials

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J1508	(1993) Hose Clamps

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 5	(1994) White Metal Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 174	(1996) Household Electric Storage Tank Water Heaters
UL 430	(1994; Rev Nov 95) Waste Disposers

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 PERFORMANCE REQUIREMENTS

1.3.1 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. Structural members shall be welded in accordance with Section 05120 STRUCTURAL STEEL.

1.3.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with Section 16640 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE).

1.4 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.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Welding; FIO.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features; FIO.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

SD-04 Drawings

Plumbing System; FIO.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. 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.

Electrical Schematics; FIO.

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-06 Instructions

Plumbing System; FIO.

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-09 Reports

Tests, Flushing and Sterilization; FIO.

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; FIO.

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-13 Certificates

Materials and Equipment; FIO.

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance. 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; FIO.

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-19 Operation and Maintenance Manuals

Plumbing System; FIO.

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.

Reverse Osmosis System; FIO.

Complete piping schematic diagram including instrumentation and control, and sequence of operation.

1.6 REGULATORY REQUIREMENTS

1.6.1 Plumbing

Plumbing work shall be in accordance with NAPHCC-01.

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 Std 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. Hubless cast-iron soil pipe shall not be installed 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 shall not be used under ground. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: ASTM A 74, AWWA C606.

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: Ductile Iron ASTM A 536 (Grade 65-45-12), Malleable Iron ASTM A 47, Grade 32510.

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1.5 mm 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. Silver brazing materials shall be in accordance with AWS A5.8.

h. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

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: ASTM C 564.

l. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 110 degrees C.

m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 orASTM F 477.

n. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

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 andASTM D 2855.

r. 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. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Asphalt Roof Cement: ASTM D 2822.

b. Hose Clamps: SAE J1508.

c. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

d. Metallic Cleanouts: ASME A112.36.2M.

e. 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.

f. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

g. Hypochlorites: AWWA B300.

h. Liquid Chlorine: AWWA B301.

i. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

j. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.

k. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 andMSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 65 mm and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm 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	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
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 Backwater Valves

Backwater valves shall be either separate from the floor drain or a combination floor drain, P-trap, and backwater valve, as shown. Valves shall have cast-iron bodies with cleanouts large enough to permit removal of interior parts. Valves shall be of the flap type, hinged or pivoted, with revolving disks. Hinge pivots, disks, and seats shall be nonferrous metal. Disks shall be slightly open in a no-flow no-backwater condition. Cleanouts shall extend to finished floor and be fitted with threaded countersunk plugs.

2.3.2 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 20 mm male inlet threads, hexagon shoulder, and 20 mm hose connection. Faucet

handle shall be securely attached to stem.

2.3.3 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickle-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 20 mm exposed hose thread on spout and 20 mm male pipe thread on inlet.

2.3.4 Lawn Faucets

Lawn faucets shall be brass, with either straight or angle bodies, and shall be of the compression type. Body flange shall be provided with internal pipe thread to suit 20 mm pipe. Body shall be suitable for wrench grip. Faucet spout shall have 20 mm exposed hose threads. Faucet handle shall be securely attached to stem.

2.3.5 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

2.3.6 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 60 kw Btuh shall have 20 mm minimum inlets, and 20 mm outlets. Relief valves for systems where the maximum rate of heat input is greater than 60 kw Btuh shall have 25 mm minimum inlets, and 25 mm 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 withNAPHCC-01. 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 82 degrees C water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

Enameled cast-iron lavatories shall be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets shall be porcelain enameled. Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

2.4.2 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 approves 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 toASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Air gaps in plumbing systems shall conform to ASME A112.1.2. The backflow preventers shall be manufactured by Watts Regulator Company or approved equal.

2.6 DRAINS

2.6.1 Floor and Shower Drains

Floor and shower 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 or caulked connection. In lieu of a caulked joint 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 and shower drains shall conform to ASME A112.21.1M.

2.6.1.1 Metallic Shower Pan Drains

Where metallic shower pan membrane is installed, polyethylene drain with corrosion-resistant screws securing the clamping device shall be provided. Polyethylene drains shall have fittings to adapt drain to waste piping. Polyethylene for floor drains shall conform to ASTM D 1248. Drains shall have separate cast-iron "P" trap, circular body, seepage pan, and strainer, unless otherwise indicated.

2.6.1.2 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 300 mm nominal overall width or diameter and 254 mm nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.21.1M.

2.6.3 Floor Sinks

Floor sinks shall be square, with 300 mm nominal overall width or diameter and 254 mm nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, aluminum sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

2.6.4 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 100 mm. The grate area shall be not less than 654 square mm.

2.6.5 Pit Drains

Pit drains shall consist of a body, integral seepage pan, and nontilting perforated or slotted grate. Drains shall be of double drainage pattern suitable for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drain pipe. Membrane or flashing clamping device shall be provided when required. Drains shall be cast iron with manufacturer's standard coating. Drains shall be circular and provided with bottom outlet suitable for inside caulked connection, unless otherwise indicated. Drains shall be provided with separate cast-iron "P" traps, unless otherwise indicated.

2.6.6 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.21.2M, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 3.5 mm. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

2.7 SHOWER PAN

Shower pan may be copper, or nonmetallic material.

2.7.1 Sheet Copper

Sheet copper shall be 16 ounce weight.

2.7.2 Plasticized Polyvinyl Chloride Shower Pan Material

Material shall be sheet form. The material shall be 1 mm minimum thickness of plasticized polyvinyl chloride or chlorinated polyethylene and shall be in accordance with ASTM D 4551.

2.7.3 Nonplasticized Polyvinyl Chloride (PVC) Shower Pan Material

Material shall consist of a plastic waterproofing membrane in sheet form. The material shall be 1 mm minimum thickness of nonplasticized PVC and shall have the following minimum properties:

a. ASTM D 638:

Ultimate Tensile Strength:	17927 kpa
Ultimate Elongation:	398 percent
100 Percent Modulus:	3068 kpa

b. ASTM D 1004:

Tear Strength:	37 kg/m

c. ASTM E 96:

Permeance:	0.008 perms

d. Other Properties:

a. ASTM D 638:

Specific Gravity:	1.29
PVC Solvent:	Weldable
Cold Crack:	-30 degrees C
Dimensional stability, 100 degrees C	minus 2.5 percent
Hardness, Shore A:	89

2.8 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 0.80 mm 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 50 mm. The interior diameter shall be not more than 3 mm 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.

2.9 WATER HEATER

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls adjustable from 32 to 49 degrees C. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and stand by heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that the storage capacity need not meet the standard loss requirement if the tank surface area is not insulated to R-12.5 and if a standing light is not used.

2.9.1 Automatic Storage Type

Heaters shall be complete with control system and shall have ASME rated combination pressure and temperature relief valve.

2.9.2 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 21982 wh or less or ANSI Z21.10.3 for heaters with input greater than 21982 wh.

2.9.3 Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be 4.5 kW. The elements shall be wired so that only one element can operate at a time.

2.10 PUMPS

2.10.1 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 and with a split or solid cast-iron or steel cover plate. The pumps shall be direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Each pump shall be fitted with a high-grade thrust bearing mounted above the floor. Each shaft shall have an alignment bearing at each end, and the suction inlet shall be between 76 mm and 152 mm above the sump bottom. 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.

2.10.2 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 toHI 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 Section16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

2.11 DOMESTIC WATER SERVICE METER

Cold water meter shall be of the positive displacement type conforming to AWWA C700. Meter register may be round or straight reading type, as provided by the local utility. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

2.12 REVERSE OSMOSIS SYSTEM

Contractor shall provide reverse osmosis system with a nominal capacity of 1550 gallons per day, designed for commercial application, and suitable for wall mounting. As a minimum the system shall consist of thin film composite membranes 4 x 40 inches in stainless steel or fiberglass pressure vessels, NEMA 4 industrial control panel with product tank level control, control transformer and low pressure switch standard, stainless steel rotary vane or multistage centrifugal pumps flange mounted to 2 hp 460 volt three phase motors for energy efficiency, and system shall be capable of operation at up to 300 psig for optimum membrane performance.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Hubless cast-iron pipe shall not be installed under concrete floor slabs. Piping located in air plenums shall conform to NFPA 90A requirements. Unprotected plastic pipe shall not be installed in air plenum. 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 150 mm 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 300 mm below the average local frost depth. 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 15 mm 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 excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm 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 20 mm hose bibb with renewable seat and gate valve ahead of hose bibb. At other low points, 20 mm 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 15 meter 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.

3.1.2 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 Union and Flanged

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm and smaller; flanges shall be used on pipe sizes 80 mm 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. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA-02 with flux and are acceptable for line 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 lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA-02.

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 ensure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC-01 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 pipe shall be made with dielectric unions or flange 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 cast-iron soil 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 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 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 100 mm above the finished floor. Unless

otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. 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 07920 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe 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 15 mm 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 concrete 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.

3.1.5.2 Flashing Requirements

Pipes passing through roof or floor waterproofing membrane 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 200 mm 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 254 mm. 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 40 mm 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 40 mm; 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 200 mm 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 40 mm 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 150 mm 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 6 to 15 mm wide by 6 to 10 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07920 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 accordance with the architectural specifications.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 50 mm 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.

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 shown. 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 100 mm and larger when the temperature of the medium is 16 degrees C or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 100 mm.

(2) Be used on insulated pipe 100 mm and larger when the temperature of the medium is 16 degrees C or less.

(3) Have a high density insert for pipe 50 mm and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 128 kg/m^3 or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 2500 mm apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 49 degrees C for PVC and 82 degrees C 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 4500 mm nor more than 2400 mm from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 128 kg/m^3 or greater.

l. 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 100 mm and larger when the temperature of the medium is 16 degrees C 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 100 mm and larger carrying medium less that 16 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

m. 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.

n. 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 100 mm or by an amount adequate for the insulation, whichever is greater.

o. 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 100 mm 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 100 mm. 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 450 mm 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.

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 and NFPA 31 for oil 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 600 mm 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 600 mm 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

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. Bumpers for water closet seats shall be installed on the wall.

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 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5 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.

3.3.5.1 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.

3.3.5.2 Support for Cellular-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 cellular wall using through bolts and a back-up plate.

3.3.5.3 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.

3.3.5.4 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, 6 mm 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.

3.3.5.5 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.

3.3.6 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 NAPHCC-01 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. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.7 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.

3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 50 mm above the flood rim of the funnel to provide an acceptable air gap.

3.3.9 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.

3.3.10 Shower Pans

Before installing shower pan, subfloor shall be free of projections such as nail heads or rough edges of aggregate. Drain shall be a bolt-down, clamping-ring type with weepholes, installed so the lip of the subdrain is flush with subfloor.

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 150 mm for turnup on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish. Subflooring shall be smooth and clean, with nailheads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

3.3.10.2 Metal Shower Pans

When a shower pan of required size cannot be furnished in one piece, metal pieces shall be joined with a flatlock seam and soldered or burned. The corners shall be folded, not cut, and the corner seam shall be soldered or burned. Pans, including upstands, shall be coated on all surfaces with one brush coat of asphalt. Asphalt shall be applied evenly at not less than 3.78 litre per 5 square meter. A layer of felt covered with building paper shall be placed between shower pans and wood floors. The joining surfaces of metal pan and drain shall be given a brush coat of asphalt after the pan is connected to the drain.

3.3.10.3 Nonplasticized Chlorinated Polyethylene Shower Pans

Corners of nonplasticized chlorinated polyethylene shower pans shall be folded against the upstand by making a pig-ear fold. Hot-air gun or heat lamp shall be used in making corner folds. Each pig-ear corner fold shall be nailed or stapled 15 mm from the upper edge to hold it in place. Nails shall be galvanized large-head roofing nails. On metal framing or studs, approved duct tape shall be used to secure pig-ear fold and membrane. Where no backing is provided between the studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding 15 mm from upper edge. To adhere the membrane to vertical surfaces, the back of the

membrane and the surface to which it will be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Surfaces to be solvent-welded shall be clean. Surfaces to be joined with xylene shall be initially sprayed and vigorously cleaned with a cotton cloth, followed by final coating of xylene and the joining of the surfaces by roller or equivalent means. If ambient or membrane temperatures are below 4 degrees C the membrane and the joint shall be heated prior to application of xylene. Heat may be applied with hot-air gun or heat lamp, taking precautions not to scorch the membrane. Adequate ventilation and wearing of gloves are required when working with xylene. Membrane shall be pressed into position on the drain body, and shall be cut and fit to match so that membrane can be properly clamped and an effective gasket-type seal provided. On wood subflooring, two layers of 15 pound dry felt shall be installed prior to installation of shower pan to ensure a smooth surface for installation.

3.3.10.4 Nonplasticized Polyvinyl Chloride (PVC) Shower Pans

Nonplasticized PVC shall be turned up behind walls or wall surfaces a distance of not less than 150 mm in room areas and 80 mm above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of curb. Corners shall be pig-ear type and folded between pan and studs. Only top 25 mm of upstand shall be nailed to hold in place. Nails shall be galvanized large-head roofing type. Approved duct tape shall be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding at top 25 mm of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Trim for drain shall be exactly the size of drain opening. Bolt holes shall be pierced to accommodate bolts with a tight fit. Adhesive shall be used between pan and subdrain. Clamping ring shall be bolted firmly. A small amount of gravel or porous materials shall be placed at weepholes so that holes remain clear when setting bed is poured. Membrane shall be solvent welded with PVC solvent cement. Surfaces to be solvent welded shall be clean (free of grease and grime). Sheets shall be laid on a flat surface with an overlap of about 50 mm. Top edge shall be folded back and surface primed with a PVC primer. PVC cement shall be applied and surfaces immediately placed together, while still wet. Joint shall be lightly rolled with a paint roller, then as the joint sets shall be rolled firmly but not so hard as to distort the material. In long lengths, about 600 mm or 900 mm at a time shall be welded. On wood subflooring, two layers of 7 kg felt shall be installed prior to installation of shower pan to ensure a smooth surface installation.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 15 percent of the lowest equipment rpm.

3.5 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.6 IDENTIFICATION SYSTEMS

3.6.1 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 35 mm 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.

3.6.2 Color Coding

Color coding for piping identification shall be as specified in Section09900 PAINTING, GENERAL.

3.6.3 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 10 mm 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 900 mm width, 750 mm height, and 15 mm thickness. The board shall be made of wood fiberboard and framed under glass or 2 mm transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 20 mm in diameter and the related lettering in 15 mm high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated in Section 09900 for exposed areas.

3.7 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.

3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in

concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

3.9 TESTS FLUSHING AND STERILIZATION

3.9.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC-01.

3.9.1.1 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.

3.9.1.2 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 25 mm for a period of 24 hours. Any drop in the water level during test, except for evaporation, will be reason for rejection, repair, and retest.

3.9.2 Phenolic Resin Coatings

A certificate of compliance shall be submitted by the coating manufacturer that documents successful use of coating system under service conditions indicated on the drawings for a minimum of 2 years at three different locations, and that the coating material and application comply with the testing procedures outlined.

3.9.2.1 Test Panels

Steel test panel substrate shall be 24 gauge in thickness. The panels shall be coated with one coat wash primer, then pigmented baking phenolic to a dry film thickness of 4 to 6 mil, then clear baking phenolic to a total dry film thickness of 5 to 7 mil. The panels shall then be subjected to the tests specified below:

a. Heat Test: Test panel shall be minimum 70 mm x 150 mm in size. A coated test panel shall show no cracking, flaking, or other failure after the panel has been tested in accordance with ASTM D 2485, with a furnace temperature of 204 degrees C.

b. Abrasion Test: A coated test panel shall show no more than a 40 milligram loss when tested in accordance with ASTM D 4060, utilizing a Tabor Abraser CS-17F wheel with a 1000 g weight for 1000 cycles.

c. Corrosion Test: A coated test panel shall show no corrosion after being subjected to a 500 hour salt spray test in accordance with ASTM B 117.

3.9.3 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 permitted.

3.9.4 System Flushing

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service 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 work is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.9.5 Operational Test

Upon completion of and prior to acceptance of the installation, 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.

3.9.6 Disinfection

After pressure tests have been made, the entire domestic hot- and cold-water distribution system shall be sterilized. System shall be thoroughly flushed with water of sufficient velocity until all entrained dirt and other foreign material have been removed, 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 sterilized 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. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. From several points in the system the Contracting Officer will take samples of water in properly sterilized containers for bacterial examination. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-01. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilizing 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.

3.10 PLUMBING FIXTURE SCHEDULE

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - CID A-A-238, Type A, white 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 65 mm at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 litres per flush.

Flush Tank - An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge, and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having their flush valve seat located below the flood level rim of the closet bowl shall have a ballcock installed within a

sheath or in a separate and isolated compartment of the tank, both to have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing. The water supply to flush tanks equipped for automatic flushing shall be controlled by a suitable timing device. Ballcocks shall meet ASSE 1002.

Flush Valve in Flush Tank - Flush valve seats in tanks for flushing water closets shall be at least 25 mm above the flood level rim of the bowl connected thereto, except in approved water closet and flush tank combinations designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve shall close tightly so that water will not spill continuously over the rim of the bowl or back flow from the bowl to the tank.

P-2 WATER CLOSET HANDICAPPED:

Top rim of bowl shall be 450 mm above the floor; 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 6 litres per flush.

P-4 LAVATORY:

Manufacturer's standard sink depth, enameled cast iron ASME A112.19.1M.

Faucet - Faucets shall be single control, mixing 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 1 litre per cycle at a flowing water pressure of 550 kpa 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 .16 L/S at a flowing pressure of 550 kpa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be stainless steel. Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

P-5 WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 500 mm wide x 675 mm deep with gooseneck spout. Flow shall be limited to 1 liter per cycle at a flowing water pressure of 550 kpa if a metering device or fitting is used that limits the period of water discharge such as foot switch or fixture occupancy sensor. If a metering device is not used, the flow shall be limited to 0.16 L/S at a flowing water pressure of 550 kpa.

Drain - Strainer shall be copper alloy or stainless steel.

P-6 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steelASME A112.19.3M trap standard 600 mm wide x 500 mm deep, splashback 225 mm high mounted as indicated.

Faucet and Spout - Cast or wrought copper alloy, without top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever 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 150 mm diameter.

P-8 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 0.16 L/S when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower head shall be nonadjustable spray, stainless steel or chromium plated brass with ball joint. Handles shall be manufacturer's option. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be mechanical mixing, single lever type. Shower head shall be vandalproof with integral back.

Column Showers: Column showers shall have a 1800 mm column height measured from floor to shower head, 15 mm IPS threads.

P-9 WATER COOLER DRINKING FOUNTAINS:

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 10 degrees C with an inlet water temperature of 27 degrees C while residing in a room environment of 32 degrees C, 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 100 mm 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 330 mm wide, 325 mm deep, and have a back height of 150 to 200 mm. The bowl shall be made of corrosion resisting steel. The unit shall have concealed fasteners and be for interior installation.

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 375 mm wide, 500 mm deep, with a back height of 150 to 200 mm. The unit shall clear the floor or ground by at least 200 mm. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 675 mm and between the front edge of the bowl and the body of the unit of at least 200 mm. A 200 mm wide clear space shall exist on both sides of the unit. The spout height shall be no more than 900 mm 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 160 mm high,

made of corrosion resisting steel and be for interior installation.

3.11 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.

3.12 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = o (trace is permitted).

SL = Standby loss in W/m^2 based on 27 degrees C delta T, or in percent per hour based on nominal 32 degrees C delta T.

HL = Heat loss of tank surface area.

V = Storage volume in litres.

3.12.1 Storage Water Heaters

3.12.1.1 Electric

a. Storage capacity of 450 litres or less, and input rating of 12 kW or less: minimum energy factor (EF) shall be 0.95-0.00132V per 10 CFR 430.

b. Storage capacity of more than 450 litres or input rating more than 12 kW: maximum SL shall be 20 W/m^2 per ASHRAE 90.1, Addenda B.

3.12.1.2 Gas

a. Storage capacity of 378 litres or less, and input rating of 22 kw.h or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 378 litres - or input rating more than 22 kw.h: Et shall be 77 percent; maximum SL shall be 1.3+38/V, per ANSI Z21.10.3.

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron pipe and fittings hubless, CISPI 301 and ASTM A 888	X	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	
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47	X	X		X	X	
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47 for use with Item 5	X	X		X	X	
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5	X	X		X	X	
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B 75 C12200, ASTM B 152 C11000, ASME B16.22 ASME B16.22 for use with Item 5	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, Type S, Grade B	X			X	X	
11	Seamless red brass pipe, ASTM B 43			X	X		
12	Bronzed flanged fittings,				X	X	

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	C	D	E	F
	ASME B16.24 for use with Items 11 and 14						

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	C	D	E	F
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	
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661	X	X	X	X	X	X
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665, ASTM F 891, (Sch 40)	X	X	X	X	X	X
21	Process glass pipe and fittings, ASTM C 1053						X
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A 518		X			X	
23	Polypropylene (PP) waste pipe and fittings, ASTM D 4101						X
24	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996						X

SERVICE:

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	C	D	E	F

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
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X	X
	b. Same as "a" but not galvanized for use with Item 4b			X	
2	Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47, non-ferrous pipe, ASTM A 536 and ASTM A 47	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47 for use with Item 2	X	X	X	
4	Steel pipe: a. Seamless, galvanized, ASTM A 53, Type S, Grade B	X	X	X	X
	b. Seamless, black, ASTM A 53, Type S, Grade B			X	
5	Seamless red brass pipe, ASTM B 43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Item 4	X	X		X
7	Seamless copper pipe, ASTM B 42	X	X		X
8	Seamless copper water tube, ASTM B 88	X**	X**	X**	X***
9	Seamless and welded copper distribution tube (Type D) ASTM B 641	X**	X**	X**	X****
10	Cast bronze threaded fittings, ASME B16.15 for use with Items 7 and 8	X	X		X
11	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 7 and 8	X	X	X	X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
12	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 7 and 8	X	X	X	X
13	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2	X	X	X	
14	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
15	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
16	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
17	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261 for use with Items 12, 13, and 16	X			X
18	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 13	X			X
19	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
20	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846	X	X		X
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40 and 80, ASTM F 441	X			X
22	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442	X			X
23	Threaded chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 80, ASTM F 437, for use with Items 20, and 21	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438	X	X		X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
	for use with Item 23				
25	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use with Item 23	X	X		X

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE			
Item No.	Pipe and Fitting Materials	A	B	C	D
26	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
27	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
28	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X
29	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467	X			X
30	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
31	Joints for IPS pvs pipe using solvent cement, ASTM D 2672	X			X
32	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996	X	X		
33	Steel pipeline flanges, MSS SP-44	X	X		
34	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X		
35	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
36	Malleable-iron threaded pipe unions ASME B16.39	X	X		
37	Nipples, pipe threaded ASTM A 733	X	X	X	

A - Cold Water Aboveground

B - Hot Water 82 degrees C Maximum Aboveground

C - Compressed Air Lubricated

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	STORAGE CAPACITY GALLONS	INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Elect.	120 max.	12 kW max.	10 CFR 430	EF = 0.95-0.00132V minimum
Elect.	120 min. OR	12 kW min.	ASHRAE 90.1 (Addenda B)	SL = 20 W/m^2 maximum
Gas	100 max.	22 kw.h max.	10 CFR 430	EF = 0.62-0.0019V minimum
Gas	100 min. OR	20 kw.h Btu/	ANSI Z21.10.3	ET = 77 percent; SL = 1.3+38/V max.

TERMS:

EF = Energy factor, overall efficiency.
ET = Thermal efficiency with 21 degrees C delta T.
EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
SL = Standby loss in W/m^2 based on 27 degrees C delta T, or in percent per hour based on nominal 32 degrees C delta T.
HL = Heat loss of tank surface area.
V = Storage volume in litres.

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SECTION 15488

GAS PIPING SYSTEMS

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 Z21.45	(1992; Z21.4a; Z21.4b) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(1994) Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 539	(1990a) Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) 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	(1995) Power Piping
ASME B31.2	(1968) Fuel Gas Piping
ASME B36.10M	(1985; R 1994) Welded and Seamless Wrought Steel Pipe
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and

	Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1992) National Fuel Gas Code
NFPA 70	(1996) National Electrical Code

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 6	(1994) Commercial Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL-06	(1994; Supple; Rev thru March 1996) 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 05120 "Structural Steel".

1.2.2 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.

1.2.3 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 "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Qualifications; FIO.

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

SD-04 Drawings

Gas Piping System; FIO.

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.

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 buttwelding fittings shall conform to ASME B16.9. Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

2.1.2 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL-06, Class 20 or less. Tetrafluoroethylene tape shall conform to UL-06.

2.1.3 Identification

Pipe flow markings and metal tags shall be provided as required.

2.1.4 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

2.1.5 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.

2.1.6 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.45.

2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

2.2.1 Valves 50 mm and Smaller

Valves 50 mm and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

2.2.2 Valves 65 mm and Larger

Valves 65 mm 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 METERS, REGULATORS AND SHUTOFF VALVES

Meters, regulators and shutoff valves shall be as specified in Section 02685 GAS DISTRIBUTION SYSTEM.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02222 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 02685 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 02685 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 and primed with ferrous metal primer. Primed surface shall be finished with two coats of exterior oil paint.

3.4 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54,AGA-01, 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.

3.4.1 Metallic Piping Installation

Underground piping shall be buried a minimum of 650 mm 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 Piping Buried Under Buildings

Underground piping installed beneath buildings shall be run in a steel pipe casing protected from corrosion with protective coatings as specified in Section 02685 GAS DISTRIBUTION SYSTEM. The casing shall extend at least 100 mm outside the building. The pipe shall have spacers and end bushings to seal at both ends to prevent the entrance of water and escape of gas. A vent line from the annular space shall extend above grade outside to a point where gas will not be a hazard and shall terminate in a rain- and insect-resistant fitting.

3.4.4 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.

3.4.4.1 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.

3.4.4.2 Piping in Floors

Piping in solid floors shall be laid in channels suitably covered to permit access to the piping with minimum damage to the building.

3.4.5 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.

3.4.6 Final Gas Connections

Unless otherwise specified herein, final connections shall be made with rigid metallic pipe and fittings. Flexible connectors may be used for final connections to gas utilization equipment. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. 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 40 mm in diameter may be made with approved tetrafluoroethylene tape. Threaded joints up to 50 mm 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.

3.6 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 100 mm above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 6 mm 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.

3.7 PIPES PENETRATING WATERPROOFING MEMBRANES

Pipes penetrating waterproofing membranes shall be installed as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

3.8 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.

3.9 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.

3.10 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched.

3.11 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 ofMSS 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 3 mm shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

3.12 ELECTRICAL BONDING AND GROUNDING

A gas piping system within a building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70.

3.13 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.

3.14 CATHODIC PROTECTION

Cathodic protection shall be provided for underground ferrous gas piping.

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 1.5 kg 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 45 gram. The source of pressure shall be isolated before the pressure tests are made.

3.15.2 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.

3.15.3 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.

3.15.4 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

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SECTION 15569

WATER AND STEAM HEATING; AND HUMIDIFYING, GAS OR BOTH; UP TO 6,000 KW

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 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105	(1997) Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1994) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 183	(1983, R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193	(1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234	(1996) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 366	(1991; R 1993) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 515	(1992) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516	(1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 653	(1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 32	(1995a) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper-Alloy Tube and Fittings
ASTM C 27	(1993) Fireclay and High-Alumina Refractory Brick
ASTM C 34	(1993) Structural Clay Load-Bearing Wall Tile
ASTM C 155	(1988; R 1992) Classification of Insulating Firebrick
ASTM C 401	(1991) Alumina and Alumina Silicate Castable Refractories
ASTM D 596	(1991) Reporting Results of Analysis of Water
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2000	(1990; R 1994) Rubber Products in Automotive Applications
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 1097	(1991) Mortar, Refractory (High-Temperature, Air-Setting)
ASTM F 1139	(1988; R 1993) Standard Specification for Steam Traps and Drains

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) 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	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(1988) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B19.3	(1991; B19.3a; B19.3b) Safety Standard for Compressors for Process Industries
ASME B31.1	(1995) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IV	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IV, Heating Boilers
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding

	and Brazing Qualifications
ASME CSD-1	(1992; CSD-1a; CSD-1b) Controls and Safety Devices for Automatically Fired Boilers
ASME PTC 10	(1965; Errata; R 1992) Compressors and Exhausters

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) 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) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA 404/0 RR	(1993) Copper Tube for Plumbing, Heating, Air Conditioning and Refrigeration

EXPASION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA-01	(1993) EJMA Standards

HYDRONICS INSTITUTE (HYI)

HYI-01	(1996) 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	(1993) 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	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends

MSS SP-72	(1992) Ball Valves with Flanged or Butt-welding Ends for General Service
MSS SP-73	(1991) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1992) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(1992) Installation of Oil Burning Equipment
NFPA 54	(1992) National Fuel Gas Code
NFPA 70	(1996) National Electrical Code
NFPA 85C	(1991) Prevention of Furnace Explosions/Implosions in Multiple Burner Boiler-Furnaces
NFPA 211	(1992) Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances
NFPA 8501	(1992) Single Burner Boiler Operations

UNDERWRITERS LABORATORIES (UL)

UL-06	(1996) Gas and Oil Equipment Directory
UL 296	(1994; Rev Aug 1995) Oil Burners
UL 726	(1995) Oil-Fired Boiler Assemblies
UL 795	(1994; Rev Jan 1996) Commercial-Industrial Gas Heating Equipment
UL 1738	(1993) Venting Systems for Gas-Burning Appliances, Categories II, III and IV

1.2 GENERAL REQUIREMENTS

1.2.1 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.

1.2.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

1.2.3 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.

1.2.4 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 05120 "Structural Steel".

1.2.5 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.

1.2.6 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 byASME 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. Structural members shall be welded in accordance with Section 05120, "Structural Steel".

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data
Manufacturer's Catalog Data; FIO.

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
Fuel Oil Storage System
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; FIO.

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; FIO.

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 and Fuel Systems Test Procedures; FIO.

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

Welding Procedures; FIO.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

Qualification; FIO.

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.

Welding Qualification; FIO.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

SD-04 Drawings

Heating System; FIO.

Detail drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of 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 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-06 Instructions

Posted Instructions; FIO.

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.

SD-07 Schedules

Tests; FIO.

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

SD-09 Reports

Heating System and Fuel System Tests; FIO.

Test reports for the heating system tests and the fuel system test, upon completion of testing complete with results.

Water Treatment Tests; FIO.

(1) 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.

(2) A test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions.

SD-13 Certificates

Bolts; FIO.

Written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this

certification.

Boiler Emissions; FIO.

Written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

SD-19 Operation and Maintenance Manuals

Heating System; FIO.

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; FIO.

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality.

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, natural draft/atmospheric burner, 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

Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base. The heat input rate for finned tube designs shall not be greater than 38 kw/m^2 based on internal heater area. The heat input rate for other boilers shall not be greater than 21 kw/m^2 of fireside heating surface.

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 206 kpa.

b. Operating pressure at boiler outlet 206 kpa.

c. Hot water temperature 82 degrees C.

d. Temperature differential between boiler discharge and system return 10 degrees C.

e. Water pressure drop 69 kpa.

f. Outdoor ambient air temperature 21 degrees C (max), 2 degrees C (min).

g. Site elevation 168 meter.

h. Maximum continuous capacity 351.4 kw.

i. Rated capacity 351.4 kw.

j. Maximum exhaust stack temperature 200 degrees C.

k. Gas fired boilers with a capacity of greater than or equal to 88 kw shall have a combustion 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. As a minimum, the following emission requirements shall be met:

NOx - 20 parts per million (ppm) corrected to 3% 02

2.2.1 Gas Fired Burners and Controls

Burners shall be UL approved natural draft/atmospheric burners. 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 117 kw per combustion chamber shall conform to UL 795. Gas fired units less than 3700 kw Btuh input shall conform to ANSI Z21.13.

2.2.2 Draft Damper

Boilers shall be provided with draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler.

2.2.3 Electrical controls

Electrical control devices shall be rated at 120 volts and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.2.4 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. 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.

2.2.5 Boiler Combustion Controls and Positioners

a. Gas fired 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.

b. 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 0.25 mm of water column.

2.2.6 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 100 mm 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.

2.2.6.1 Low-water Cutoff

Low-water cutoff shall be provided to stop the burner and draft fan when the water level drops below a predetermined point. The cutoff shall consist of a float chamber with float, float switch, and drain valve. The float switch shall be mounted on the float chamber with a packless-type leakproof connection. The float mechanism and drain valve shall be constructed of a corrosion-resistant material. The low-water cutoff shall be UL-06 listed and shall be furnished with approved fittings and installed according to ASME boiler code requirements. The following type of low-water cutoff shall be utilized.

a. Feedwater Regulator with Low-Water Cutoff: Regulator shall be an approved design sized for the application. A regulator shall be provided for each boiler. The feeder shall be so arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. The boiler feeder shall be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder shall be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat shall be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats shall be removable and renewable. The regulator shall be equipped with a large, self-cleaning strainer. The drain valve on the regulator shall be the gate or other straight-through type.

2.2.6.2 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.

2.3 SPACE TEMPERATURE

Space relative humidity shall be controlled within plus or minus 5 percent of the set point over a range of 45 to 55 percent with a set point of 50 p percent.

2.5 HUMIDIFIER

2.5.1 Steam Spray Type

Steam spray humidifiers shall inject steam directly into the air stream. Package type steam spray humidifiers shall be equipped to trap out and to evaporate condendsate and to supply dry steam to a single distribution grid. Grid shall be steam jacketed and condensate drained. Unit shall trap excess condensate to return system. Package type steam spray humidifiers shall have modulating, electronic, steam control valve, as indicated. Steam spray humidifiers shall be rated for humidifying capacity in pounds of steam per hour and at steam pressure as indicated.

2.4 Steam-Diffuser Type

Diffuser units shall be of a design that will separate any condensate from steam supply and provide positive drain of condensate to waste and supply dry steam only to air stream. Humidifiers may be installed on single or multiple units. Materials shall be Type 300 stainless steel.

2.5 PUMPS

2.5.1 Hot Water Circulating Pumps

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. Hot water circulating pumps shall be supported on a concrete foundation with a cast iron or structural steel base and shall have a closed-coupled shaft or flexible-coupled shaft. 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 116 degrees C 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. The hot water circulating pump discharge heater shall be provided with a flow switch. Flow switch unit shall be a self-contained swinging vane type to indicate fluid flow. Switch shall be a SPDT with 120-volt, 15-ampere rating.

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 Flue Gas Flow Monitor

Flue gas flow monitor shall utilize the pitot tube principle to measure the flow. The probe shall be an across-the-duct-average pitot tube and shall be designed and located to obtain representative measurement. Differential pressure transmitters shall be used to sense the difference between he static and total pressure of the flowing gas stream. Calibrations shall be stable. Lines shall be arranged to prevent collection of condensate. A purge system shall be provided as required to keep the pitot pressure taps clear.

2.8.1.1 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.

2.8.1.2 Exhaust Vent

The exhaust vent piping shall be constructed of Schedule 40 PVC or stainless steel conforming to UL 1738 and the boiler manufacturer's recommendations. The exhaust vent shall be suitable for the maximum anticipated boiler exhaust temperature and shall withstand the corrosive effects of the condensate. A 0.8 mm diameter hole shall be provided in the stack not greater than 150 mm 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.

2.8.2 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 862 kpa 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 120 degrees C.

2.8.3 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 862 kpa. The capacity of the air separation tank indicated is minimum.

2.8.4 Filters

Filters shall conform to CID A-A-1419.

2.8.5 Foundation (Setting) Materials

2.8.5.1 Firebrick

Firebrick shall be ASTM C 27 class as recommended by boiler manufacturer.

2.8.5.2 Tile

Tile shall be ASTM C 34, Grade LBX.

2.8.5.3 Insulating Brick

Insulating brick shall comply with ASTM C 155.

2.8.5.4 Refractory Mortar

Refractory mortar shall comply with ASTM F 1097.

2.10.6.5 Castable Refractories

Castable refractories shall be ASTM C 401. The minimum modulus of rupture for transverse strength shall be not less than 4191 kpa after being heat soaked for 5 hours or more at a temperature in excess of 1371 degrees C.

2.8.6 Steel Sheets

2.8.6.1 Galvanized Steel

Galvanized steel shall be ASTM A 653.

2.8.6.2 Uncoated Steel

Uncoated steel shall be ASTM A 366, 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, 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. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

2.8.8.4 Welded Fittings

Welded fittings shall conform to ASTM A 234 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.

2.10.9.7 Unions

Unions shall be ASME B16.39, Class 150.

2.8.8.7 Threads

Pipe threads shall conform to ASME B1.20.1.

2.8.8.8 Grooved Mechanical fittings

Joints and fittings shall be designed for not less than 860 kpa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000, Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C or Grade N0. M3BA610A15B44Z for circulating medium up to 93 degrees C. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.8.9 Copper Tubing and Fittings

2.8.9.1 Copper Tubing

Tubing shall be ASTM B 88, 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 liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

2.8.10 Dielectric Unions

Dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. 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.

2.8.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kpa or 1048 kpa 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 209 kpa and shall be in accordance with applicable requirements of EJMA-01 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 1500 mm from expansion joint, except in lines 100 mm or smaller guides shall be installed not more than 600 mm 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-01 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 1048 kpa.

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-01. 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-01 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 65 mm and smaller shall conform to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Gate valves 80 mm 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 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.8.14.3 Check Valves

Check valves 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 80 mm and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

2.8.14.4 Angle Valves

Angle valves 65 mm and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

2.8.14.5 Ball Valves

Ball valves 15 mm 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 50 mm and larger shall conform to MSS SP-78. Plug valves smaller than 50 mm shall conform to ASME B16.34.

2.8.14.7 Grooved End Valves

Valves with grooved ends per AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

2.8.14.8 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 121 degrees C 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.

2.8.14.9 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 862 kpa of the tag rating. Valves shall be suitable for the maximum operating pressure of 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 121 degrees C 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.

2.8.14.10 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 1048 kpa. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404, 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.

2.8.14.11 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.

2.8.14.12 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 14 and 70 kpa. 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. 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 862 kpa service and 12 degrees C. 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 2.77 per square meter 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 89 mm. A pressure gauge shall be provided for each boiler in a visible location on the boiler.

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 228 mm scale.

2.8.18 Air Vents

2.8.18.1 Automatic Air Vents

Automatic air vents shall be 20 mm 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 standard 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 watertight 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 Section15250 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 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.

2.11.2 Tube Brush

If a firetube boiler is being furnished, a tube brush, with steel bristles and jointed handle of sufficient length to clean full length of firetubes,

shall be provided.

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 makeup water conditions reported per ASTM D 596 are as follows:

Date of Sample	_____	
Temperature	_____	degrees F
Silica (SiO_2)	_____	ppm (mg/1)
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 (HCO_3)	_____	ppm (mg/1)
Sulfate (SO_4)	_____	ppm (mg/1)
Chloride (C1)	_____	ppm (mg/1)
Nitrate (NO_3)	_____	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	_____	micromho/cm

2.12.2 Boiler Water Limits

The boiler manufacturer shall be consulted for the determination of the boiler water chemical composition limits. The boiler water limits shall be as follows unless dictated differently by the boiler manufacturer's recommendations:

Causticity	20-200 ppm
Total Alkalinity (CACO3)	900-1200 ppm
Phosphate	30-60 ppm
Tanin	Medium
Dissolved Solids	3000-5000 ppm
Suspended Solids	300 ppm Max
Sodium Sulfite	20-40 ppm Max
Silica	Less than 150 ppm
Dissolved Oxygen	Less than 7 ppm
Iron	10 ppm
Sodium Sulfite	20-40 ppm
Hardness	Less than 2 ppm
pH	9.3 - 9.9

2.12.3 Water Softening System

The water softening system shall be as specified in Section 11250 WATER SOFTENERS, CATION-EXCHANGE (SODIUM CYCLE).

2.12.4 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

2.12.5 Sequence of Operation

The flow rate of chemical addition shall be based upon a manual setting. The required rate of chemical feed and boiler blowdown shall be determined by the water treatment company.

2.12.6 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.

2.12.7 Chemical Piping

The piping and fittings shall be constructed of steel.

2.12.8 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 38 degrees C. 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 700 mm 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 2 percent. 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 65 mm or less in diameter and with flanges for pipe 80 mm 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 Cold Water Connections

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 35 kpa in excess of the static head on the system and shall operate within a 14 kpa tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

3.2.2 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. Grooved mechanical fittings will not be allowed for water temperatures above 110 degrees C.

3.2.3 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

3.2.4 Gauge Piping

Piping shall be copper tubing.

3.2.5 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 25 m and smaller shall be threaded; fittings 30 mm and up to but not including 80 mm shall be either threaded, grooved, or welded; and fittings 80 mm and larger shall be either flanged, grooved, or welded. Pipe and fittings 30 mm 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 65 mm or smaller in diameter and with flanges for pipe 80 mm inches or larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

3.2.5.1 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.

3.2.5.2 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 1.5 mm and no more than 3 mm.

3.2.5.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 110 degrees C. Grooves 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 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. Mechanical joints shall use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible

couplings may be used. Coupling shall be of the bolted type for use with grooved end pipes, fittings, valves, and strainers. Couplings shall be self-centering and shall engage in a watertight couple.

3.2.5.4 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 404/0 RR 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.

3.2.5.5 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 404/0 RR.

3.2.5.6 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.

3.2.6 Flanges and Unions

Flanges shall be faced true, provided with 1.5 mm 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.

3.2.7 Branch Connections

3.2.7.1 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.

3.2.8 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 404/0 RR. 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 50 mm or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA 404/0 RR.

3.2.9 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.

3.2.10 Supports

3.2.10.1 General

Hangers used to support piping 50 mm 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.

3.2.10.2 Seismic Requirements for Supports and Structural Bracing

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided in this section. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.2.10.3 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 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 7020 mm apart at valves.

h. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4572 mm, not more than 2438 mm 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 100 mm,

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 100 mm 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 23 kg. Loads exceeding 23 kg shall be suspended from panel points.

3.2.10.4 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 1.5 mm shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

3.2.11 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.

3.2.12 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.

3.2.13 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 152 mm for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 6 mm 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 07920 JOINT SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

Metal jackets shall not be thinner than 15 mm thick aluminum, if corrugated, and 40 mm thick aluminum, if smooth.

Metal jackets shall be secured with aluminum or stainless steel bands not less than 10 mm wide and not more than 200 mm apart. When penetrating roofs and before fitting the metal jacket into place, a 13 mm 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 914 mm 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 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above material to a minimum distance of 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above the floor; when passing through walls above grade, the jacket shall extend at least 100 mm beyond each side of the wall.

3.2.13.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 2 kg 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 8 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 250 mm. 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 250 mm 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.

3.2.13.2 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.

3.2.13.3 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.

3.2.13.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided.

3.2.14 Balancing Valves

Balancing valves shall be installed as indicated.

3.2.15 Thermometer Wells

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

3.2.16 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.

3.2.17 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.

3.2.18 Drains

A drain connection with a 25 mm gate valve or 20 mm 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.

3.2.19 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.

3.2.20 Direct Venting for Combustion Intake Air and Exhaust Air

The intake air and exhaust vents shall be installed in accordance with NFPA 54 and boiler manufacturer's recommendations. The exhaust vent shall be sloped 2 percent toward the boiler's flue gas condensate collection point.

3.3 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15488 GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL-06. 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 FIELD PAINTING

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 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. 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. 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 Section15990 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, ANSI Z21.13, NFPA 8501 and NFPA 85C.

3.5.1 Water Treatment Testing

3.5.1.1 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 (SiO2)	_____	ppm (mg/1)
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 (C1)	____	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	_____	micromho/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

3.5.1.2 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler 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 piping, proper repairs shall be made by the water treatment company.

3.6 CLEANING

3.6.1 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 .03 liters of caustic soda or .03 liters 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 66 degrees C 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.

3.6.2 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.

3.7 FUEL SYSTEM TESTS

3.7.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

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 operating 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

-- End of Section --

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SECTION 15650

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SECTION 15650

CENTRAL REFRIGERATED AIR-CONDITIONING SYSTEM

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.

CORPS OF ENGINEERS

Bulletin 97-08 Recommendation	Engineering Improvement System

AIR CONDITIONIN-G AND REFRIGERATION INSTITUTE (ARI)

ARI 550	(1992) Centrifugal or Rotary Screw Water-Chilling Packages
ARI 575	(1987) Method of Measuring Machinery Sound Within an Equipment Space
ARI 700	(1993) Specifications for Fluorocarbon and Other Refrigerants
ARI 710	(1986) Liquid-Line Driers
ARI 760	(1987) Solenoid Valves for Use with Volatile Refrigerants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.13	(1971; R 1986) Methods for the Measurement of Sound Pressure Levels

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 106	(1994) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 181	(1994) Forgings, Carbon Steel, for

	General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193	(1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234	(1996) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 334	(1991) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1995) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 209	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 210	(1995) Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B 280	(1993a) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 395	(1993) U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM B 650	(1993) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates
ASTM C 67	(1994) Sampling and Testing Brick and Structural Clay Tile
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

ASTM D 520	(1984; R 1989) Zinc Dust Pigment
ASTM D 596	(1991) Reporting Results of Analysis of Water
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM E 84	(1995) Surface Burning Characteristics of Building Materials
ASTM F 104	(1993) Nonmetallic Gasket Materials
ASTM F 1199	(1988, R 1993) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 1200	(1988, R 1993) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1994) Number Designation and Safety Classification of Refrigerants
ASHRAE 64	(1995) Methods of Testing Remote Mechanical-Draft Evaporative Refrigerant Condensers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
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	(1989) Wrought Copper and Copper Alloy

	Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1995) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME PTC 23	(1986; Addenda 1992; R 1992) Atmospheric Water Cooling Equipment

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS D1.1	(1994) Structural Welding Code - Steel

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA-01	(1993) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI-01	(1983) Standards for Centrifugal, Rotary, & Reciprocating Pumps

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves

MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1992) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(1993; Rev 1-1993; Rev 2-1995) Motors and Generators
NEMA SM 23	(1991) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1993) National Electrical Code
NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems
NFPA 255	(1990) Method of Test of Surface Burning Characteristics of Building Materials

UNDERWRITERS LABORATORIES (UL)

UL 1995	(1990) Heating and Cooling Equipment

1.2 SYSTEM DESCRIPTION

This specification section covers the provisions and installation procedures necessary for a complete and totally functional refrigerant system. The system shall be provided and installed with all necessary System Components, Accessories, Piping Components, and Supplemental Components\Services.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Central Refrigerated Air-Conditioning System; FIO.

Manufacturer's catalog data, at least 5 weeks prior to beginning construction, shall be highlighted to show model #, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

a. Refrigeration System
b. System Components
c. Accessories
d. Cooling Tower
e. Piping Components

If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Water Treatment Systems; FIO.

Six complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in Paragraph Water Analysis, a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply.

Qualifications; FIO.

Three copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

SD-04 Drawings

Central Refrigerated Air-Conditioning System ; FIO.

Drawings, at least 5 weeks prior to beginning construction, shall provide adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

a. Equipment layouts which identify assembly and installation details.
b. Piping layouts which identify all valves and fittings.
c. Plans and elevations which identify clearances required for maintenance and operation.
d. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.
e. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.
f. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

SD-06 Instructions

Posted Instructions; FIO.

Posted instructions, at least 2 weeks prior to construction completion, shall include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

SD-07 Schedules

Factory Tests; FIO.

Schedules, at least 2 weeks prior to the factory test, which identify the date, time, and location for each test. Schedules shall be submitted for both the Chiller Performance Test and the Chiller Sound Test. The Chiller Performance Test schedule shall also allow the witnessing of the test by a Government Representative.

Tests; FIO.

Test schedules, at least 2 weeks prior to the start of related testing, for each of the field tests, the system performance tests, and the condenser water quality tests. The schedules shall identify the date, time, and location for each test.

Demonstrations; FIO.

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-08 Statements

Verification of Dimensions; FIO.

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-09 Reports

Factory Tests; FIO.

Six copies of the report shall be provided in bound 8 1/2 by 11 inch booklets. Reports shall certify the compliance with performance requirements and follow the format of the required testing standard for both the Chiller Performance Tests and the Chiller Sound Tests. Test report shall include certified calibration report of all test instrumentation. Calibration report shall include certification that all test instrumentation has been calibrated within 6 months prior to the test date, identification of all instrumentation, and certification that all instrumentation complies with requirements of the test standard.

Field Tests; FIO.

Six copies of the report shall be provided in bound 8 1/2 by 11 inch booklets. Reports shall document all phases of tests performed during the Water Pipe Testing, the Refrigerant Pipe Testing, and the Cooling Tower Tests. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

System Performance Tests; FIO.

Six copies of the report shall be provided in bound 8 1/2 by 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

a. Date and outside weather conditions.
b. The load on the system based on the following:
   (1) The refrigerant used in the system.
   (2) Condensing temperature and pressure.
   (3) Suction temperature and pressure.
   (4) Running current, voltage and proper phase sequence for each phase of all motors.
   (5) The actual on-site setting of all operating and safety controls.
   (6) Chilled water quantity and temperature in and out of the chiller.
   (7) The position of the capacity-reduction gear at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

SD-13 Certificates

Central Refrigerated Air-Conditioning System; FIO.

Where the system, components, or equipment are specified to comply with requirements of ARI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall 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 the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a

current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

SD-19 Operation and Maintenance Manuals

Operation Manual; FIO.

Six complete copies of an operation manual in bound 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, and shutdown. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manual; FIO.

Six complete copies of maintenance manual in bound 8 1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

Water Treatment System; FIO.

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.

1.4 QUALIFICATIONS

Piping shall be welded in accordance with the 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. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, 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. Safety devices shall be installed so that proper operation of equipment is not impaired. Ladder and guardrail shall be provided where indicated and in accordance with Section 05500 MISCELLANEOUS METAL.

1.6 DELIVERY, STORAGE, AND HANDLING

All 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 PROJECT/SITE CONDITIONS

1.7.1 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 any work.

1.7.2 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 plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

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 satisfactory commercial or industrial use for two years prior to bid opening. The two-year 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, manufacturer's catalogs, or brochures. Products having less than a two-year field service record shall 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. All products shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

2.2 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. Nameplates shall be provided for:

a. Condensing and Compressors Unit(s)
b. Liquid-Chilling Package(s)
c. Compressor(s)
d. Pump(s)
e. Pump Motor(s)
f. Refrigerant Leak Detectors
g. Expansion Tanks
h. Air Separator Tanks

2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in

accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics and enclosure type shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. All motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor starter shall be provided with NEMA 1 enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 MATERIALS

2.4.1 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.4.2 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.4.3 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 set screws.

2.4.4 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 andMSS SP-69.

2.4.5 Gauges

Gauges shall conform to ASME B40.1, Class 1, 2, or 3, Style X, Type I or III as required, 4-1/2 inches in diameter with phenolic or metal case.

2.5 REFRIGERATION SYSTEM

2.5.1 Liquid-Chilling Package; Reciprocating or Scroll

Scroll unit shall be designed, fitted, tested, and rated in accordance with ARI 590 and shall meet all the requirements ofASHRAE 15. Entire unit shall be factory assembled, completely piped and wired except for units with remote condensers. Single packaged units shall be charged with refrigerant and oil ready for operation after connection to utilities. The unit shall include the following components as defined in paragraph SYSTEM COMPONENTS:

a. Refrigerant and Oil

b. Scroll Compressor
c. Compressor Driver, Electric Motor
d. Compressor Driver Connections
e. Liquid Cooler
f. Integral Air-Cooled Condenser
g. Receivers
h. Automatic Tube Brush Cleaning System
i. Tools
j. All customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment

2.5.1.1 Capacity Criteria

Unit shall have a minimum Coefficient of Performance (COP) of 2.5 at full load rating in accordance with ARI 590. Unit shall have a minimum Integrated Part Load Value (IPLV) of 2.5 in accordance with ARI 590.

2.5.1.2 Controls Package

Each water-chilling unit shall be provided with operating and safety controls of the electric or electronic type. The Contractor shall properly coordinate the chiller control system with the temperature-control system specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and 15950 HEATING, VENTILATING AND AIR CONDITIONING HVAC CONTROL SYSTEMS. Temperature sensing elements shall be located as recommended by the manufacturer. Capacity reduction may be provided by cylinder unloading, by sequence operation of two or more, but shall not exceed four compressors per circuit, or by a combination of both methods. Each unit shall be provided with a factory-piped and -wired control panel fitted with:

a. A refrigerant discharge pressure and suction pressure gauge
b. A separate high-pressure cut-out with manual reset
c. A low-temperature cutout
d. Compressor operating control
e. Entering and leaving chilled water cutout
f. Operating pilot light
g. Any other relays or appurtenances necessary for safe, controlled chiller operation
h. Auto on-off switch
i. Alarm circuit terminals to actuate a minimum 4 inch diameter alarm bell in the event of machine cutout on any protective device, except when the low-pressure control is used as an operating control. Transformer for the bell circuit requiring low voltage shall be provided by the Contractor. Oil pressure gauge and low oil pressure cutout shall be provided on compressors which utilize positive displacement type oil pumps.
j. System capacity control, pressure or temperature actuated, on systems over 10 tons to adjust the unit capacity in accordance with the system load, and to automatically re-cycle the system on power interruption.

2.5.1.3 Base

Unit shall be mounted on a structural steel or cast iron base. Compressors shall be mounted on vibration isolators. The entire unit shall be isolated from the building structure on vibration isolators with published load ratings. Vibration isolators shall have isolation characteristics as recommended by the manufacturer for the unit supplied and the service

intended.

2.5.1.4 Refrigerant Circuit

Each circuit shall include combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve, thermostatic expansion valve with external equalizer, and superheat adjustment.

2.6 SYSTEM COMPONENTS

2.6.1 Refrigerant and Oil

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. The unit shall be factory leak tested and dehydrated. Where factory does not precharge the system, Contractor shall provide and install a complete charge of refrigerant and oil required for the installed system as recommended by the manufacturer.

2.6.2 Compressor(s)

2.6.2.1 Helical Rotary Screw Compressor(s)

Compressors shall operate stably for indefinite time periods at any stage of capacity reduction without hot-gas bypass. Provision shall be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Helical rotary screw compressors shall include:

a. An accessible, hermetic, positive displacement, oil-injected design directly driven by the compressor driver.
b. Rotors which are solid steel forging with sufficient rigidity for proper operation.
c. A maximum rotor operating speed no greater than 3600 RPM.
d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors.
e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.
f. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABEMA 9 or ABEMA 11. Bearings shall be conservatively loaded and rated for an L(10) life of not less than 200,000 hours.
g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.
h. A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide automatic capacity modulation from 100 percent to 15 percent.
i. An external oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.
j. Crankcase oil heaters controlled as recommended by the manufacturer.

2.6.3 Compressor Driver, Electric Motor

Motor starter shall be unit mounted. The compressor(s) shall be driven by

an electric motor that has a maximum speed of 3,600 rpm. Motor shall be of the constant-speed, squirrel-cage induction, open enclosure, or hermetically sealed, normal- or high-torque type as required by the compressor manufacturer to adequately bring the compressor up to full operating speed without damaging the equipment. Motor shall be furnished with magnetic across-the-line as required by the unit manufacturer to limit unit total instantaneous-current flow during start-up to a maximum of 322 amps. Motor starter shall be provided with NEMA 3R enclosures with an integral circuit breaker which trips the breaker when the starter door is opened. Hermetically sealed motors shall be refrigerant-gas cooled. Wiring shall be as recommended by the compressor manufacturer to provide completely automatic operation of the system. Motors shall be protected against running overload and motor-winding temperature overloads. All compressors shall be protected from rapid on-off cycling by a 20-minute time-delay switch initiated by unit shutdown with an adjustable time delay. Motor controller shall be suitable for starting compressor motor intermittently at 20 minute intervals continuously without damage to controller.

2.6.4 Compressor Driver Connections

Each compressor shall be driven by direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. Bearings shall be of the sleeve or roller type. Pressure lubrication with pump and cooler shall be provided. Shaft extensions shall be provided with seals to retain oil and exclude all dust.

2.6.5 Liquid Cooler

Liquid coolers shall be designed, fitted, and rated in accordance withARI 590 for reciprocating and scroll compressors and ARI 550 for centrifugal or rotary screw compressors. Coolers shall be designed, constructed, tested, and certified in accordance with ASME BPV VIII Div 1 as applicable, and shall comply with the provisions of ASHRAE 15. Liquid coolers shall be designed for waterside working pressures not less than 1746 kpa. On direct-expansion-type units, refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. Liquid coolers shall be of the removable or fixed-tube bundle type except that units less than 20 tons may be coaxial-tube type. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Nominal tube thickness shall be no less than 0.028 inches. Each tube shall be individually replaceable, excluding the coaxial-tube type. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be carbon mild steel properly spaced to provide adequate tube support, and cross flow liquid cooler feed control shall be complete and designed to feed the cooler at all levels of capacity from 100 percent down to minimum required operating level. Performance shall be based on a water velocity not less than 3 fps nor more than 12 fps and fouling factor of [0.00025] [0.00075] sq. ft.-hour-degree F/btu.

2.6.6 Air-Cooled Condenser and Condensing Section

2.6.6.1 Sizing

Sizing of the condenser for full capacity at design conditions shall be based on the temperature difference between the entering outside air and the condensing refrigerant for systems with stand-alone condensers that are not part of a manufacturer matched combination and cataloged system.

Sizing of all other condensers for full capacity at design conditions shall be based on a maximum of 30 degrees F temperature difference between the entering outside air and condensing refrigerant.

2.6.6.2 Construction

Air-Cooled condenser shall be designed, fitted, tested, and rated in accordance with ARI 210/240, ARI 365, ARI 460, or ARI 590 as applicable and shall meet the requirements of ASHRAE 15. Condenser shall be an integral part of the liquid-chilling package unit. Air-cooled condenser shall be a complete factory-fabricated and assembled unit, consisting of coils, fans, and electric-motor drive. Unless the condenser coil is completely protected through inherent design, screens shall be provided by the manufacturer to prevent physical damage to the coil.

2.6.6.3 Operation

Saturated refrigerant condensing temperature shall not be over 130 degrees F unless the system can meet the unit efficiency specified on the drawings at the provided condensing temperature, in which case the manufacturer shall certify that the condenser and associated equipment are designed for the submitted condensing temperature. The saturated condensing temperature shall not exceed 145 degrees F in either case. Entering dry bulb outside design air temperature shall be as indicated. When at the design conditions, if matched combination catalog ratings matching remote condensers to compressors are not available, the Contractor shall furnish a crossplotting of the gross heat rejection of the condenser against the gross heat rejection of the compressor, for the design conditions to show the compatibility of the equipment furnished. For those periods when the refrigeration system will operate over design conditions, the equipment shall be capable of operating continuously at 10 degrees F above stated outside design air temperature without damage or shutdown of the compressor motor or shutdown of the refrigeration system by safety devices.

2.6.6.4 Condenser Coil

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless aluminum tubes with compatible aluminum fins. On condensers with all aluminum construction, tubes shall conform to ASTM B 210; alloy 1100, and aluminum alloy conforming to chemical requirements of ASTM B 209, alloy 7072 shall be used for the fins and end sheets. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coil shall be tested after assembly at pressure specified in ASHRAE 15 for the refrigerant employed in the system. Coil shall be evacuated as specified.

2.6.6.5 Fans

Fans shall be centrifugal or propeller type as best suited for the application. Fans shall be direct or V-belt driven. Belt drives shall be completely enclosed within the unit casing or equipped with a guard. When belt drive is provided, an adjustable sheave to furnish not less than 20 percent fan-speed adjustment shall be provided. Sheaves shall be selected to provide the capacity indicated at the approximate midpoint of the adjustment. Fans shall be statically and dynamically balanced.

2.6.6.6 Condenser Casing

Condenser casing shall be aluminum not less than 0.080 inch or hot-dip

galvanized steel not lighter than 18 gauge. Condensers having horizontal air discharge shall be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing.

2.6.6.7 Refrigerant Storage

Air-cooled condenser may be used for refrigerant storage in lieu of a separate receiver, if the condenser storage capacity is 5 percent in excess of the fully charged system for packaged air-cooled chillers and air-cooled condensing units with field installed refrigerant piping no longer than recommended by the manufacturer; 20 percent for all air-cooled condensers; and 20 percent for all air-cooled condensing units with field installed piping which is longer than recommended by the manufacturer.

2.6.6.8 Condenser Controls

If the equipment or system served by the condenser requires control of head pressure either air volume head pressure control or condenser flooding head pressure control shall be provided which meets the following requirements:

a. Air Volume Control: On a decrease in refrigerant discharge pressure, volume-control dampers shall modulate to control the airflow over the condenser coil. Solid-state variable-speed fan motor controller may be provided in lieu of volume dampers to control the air flow over the coil. Condensers with multiple fans may be provided with fan cycling control to cycle fans in response to outdoor ambient temperature. Control shall be set for minimum of 95 degrees F saturated refrigerant condensing temperature.

b. Condenser Flooding: On a decrease in refrigerant discharge pressure, a head pressure sensitive valve shall throttle condenser outflow to increase the amount of liquid in the condenser. A differential pressure hot-gas bypass valve shall be provided to maintain receiver pressure which opens as the receiver pressure falls. Control shall be set for minimum of 95 degrees F saturated refrigerant condensing temperature.

c. Condenser shall be provided with a low ambient temperature control package which permits the compressor to start and run and the head pressure be maintained at ambient temperatures down to 2 degrees C).

2.6.6.9 Low Ambient Control Package

Condenser shall be provided with a low ambient control package for start-up and operation down to an ambient temperature of 2 degrees C.

2.7 ACCESSORIES

2.7.1 Pumps

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI-01. Pump capacity, efficiency, motor size, and impeller type shall be as indicated on the drawings. Pumps shall be selected at or near peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Shutoff head shall be approximately 20 percent greater than design head. Pump motor shall be totally enclosed and have sufficient horsepower for the service required. 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 the cover.

2.7.1.1 Construction

Shaft seal shall be mechanical-seal or stuffing-box type. Impeller shall be statically and dynamically balanced. Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 86.2 kpa. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water. Pump and motor shall be mounted on a structural steel base with lipped edges. Pump shall be provided with shaft coupling guard. Close coupled pumps shall be provided with drip pockets and tapped openings. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump shall be accessible for servicing without disturbing piping connections.

2.7.1.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone separator in line.

2.7.1.3 Stuffing-Box Type Seals

Seals shall be single unit construction separate from the casing, secured against rotation. Stuffing box shall include minimum 5 rows of square, graphite braided asbestos packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.7.2 Expansion Tanks

Expansion tanks shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 86.2 kpa and precharged to the minimum operating pressure. Expansion tanks shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with an air charging valve. Tanks shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.7.3 Air Separator Tanks

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 86.2 kpa.

2.7.4 Signs

Metal signs shall be provided having letters not less than 0.5 inches in height designating the main shut-off valves to each refrigerant vessel, the electrical control of the chiller, and the pressure limiting device.

2.7.5 Pump-Out System

A manually initiated pump-out system shall be provided, consisting of a motor-driven, air- or water-cooled, reciprocating condensing unit and a receiver of sufficient capacity to store the entire refrigerant charge of the largest water-chilling system or unit when 80 percent full at 90 degrees F. Pump-out system condensing unit shall be assembled as a complete unit and meet the requirements of ASHRAE 15. Receiver and relief devices shall conform to requirements of ASME BPV VIII Div 1. Unit shall be mounted on the chiller or mounted on floor brackets and provided with rupture members and unit relief valves in series. Entire system shall be complete with all valves, piping, and controls so that the pump-out system may be operated without requiring any temporary wiring or piping. The pump-out system shall be capable of removing both refrigerant liquid and refrigerant vapor from the refrigeration system. The pump-out system shall be capable of reducing the pressure within the refrigeration system to 150 mm Hg.

2.7.6 Insulation

2.7.6.1 Field Installed Insulation

Field installed insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEM, except for header and waterbox insulation which shall be flexible cellular insulation in accordance withASTM C 534, Type I.

2.8 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

2.8.1 Water Analysis

Contractor shall provide a Water Analysis stating the conditions of make-up water to be supplied to the condenser and chilled water systems and shall include the following:

Date of Sample	_____
Temperature	_____ degrees F.
Silica (SiO 2)	_____ ppm (mg/1)
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 (HCO 3)	_____ ppm (mg/1)
Sulfate (SO 4)	_____ ppm (mg/1)
Chloride (Cl)	_____ ppm (mg/1)
Nitrate (NO 3)	_____ ppm (mg/1)
Turbidity	_____ unit

pH	_____
Residual Chlorine	_____ ppm (mg/1)
Total Alkalinity	_____ epm (meq/1)
Non-Carbonate Hardness	_____ epm (meq/1)
Total Hardness	_____ epm (meq/1)
Dissolved Solids	_____ ppm (mg/1)
Fluorine	_____ ppm (mg/1)
Conductivity	_____ micrmho/cm

2.8.2 Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

2.8.3 Water Treatment Services

The services of a company regularly engaged in the treatment of condenser and chilled water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the condenser and chilled water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

2.8.4 Chilled Water System

A shot feeder shall be provided on the chilled water piping as indicated. Size and capacity of feeder shall be based on local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

2.9 PIPING COMPONENTS

2.9.1 Water Piping and Fittings

2.9.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.9.1.2 Steel Pipe Joints and Fittings

Joints and fittings shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components

shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

a. Welded Joints and Fittings: Welded fittings shall conform toASTM A 234, and identified with the appropriate grade and marking symbol. Butt-welding fittings shall conform to ASME B16.9. Socket-welding and threaded fittings shall conform to ASME B16.11.

b. Flanged Joints and Fittings: Flanges shall conform to ASTM A 181 and ASME B16.5 Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. This gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193.

c. Threaded Joints and Fittings: Threads shall conform to ASME B1.20.1. Pipe nipples shall conform to ASTM A 733, type and material to match adjacent piping. Unions shall conform to ASME B16.39, type as required to match adjacent piping.

d. Dielectric Unions and Flanges: Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

e. Grooved Mechanical Joints and Fittings: Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.9.1.3 Copper Tube

Copper tubing for water service shall conform to ASTM B 88, Type K or L.

2.9.1.4 Copper Tube Joints and 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. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing 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.

2.9.2 Water Piping Valves and Accessories

Valves shall be rated for Class 125 and shall be suitable for operating temperature of 250 degrees F. Valves shall be suitable for the working pressure of the pipe in which installed. Valves shall meet the material, fabrication and operating requirements ofASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor. Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.9.2.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.9.2.2 Globe and Angle Valves

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Globe and angle valves 3 inches and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged or threaded ends.

2.9.2.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

2.9.2.4 Butterfly Valves

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be 2 flange or lug wafer type, and shall be bubble tight at 1746 kpa. Valve bodies shall be cast iron, malleable iron, or steel. 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.

2.9.2.5 Plug Valves

Plug valves 2 inches and larger shall conform toMSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valves shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valves shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves shall a

weatherproof operators with mechanical position indicators. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.9.2.6 Ball Valves

Ball valves 1/2 inch and larger shall conform toMSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.9.2.7 Calibrated Balancing Valves

Each valve shall be calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valves shall have an integral pointer which registers the degree of valve opening. Each valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves Cv rating shall be as indicated. Valve bodies shall be provided with tapped openings and pipe extensions with positive 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, suitable for the operating pressure specified, shall be provided. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer. 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.

2.9.2.8 Automatic Flow Control Valves

Valves shall automatically maintain a constant flow as indicated. Valves shall modulate by sensing the pressure differential across the valve body. 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. Valve materials shall be the same as specified for the ball or plug valves. Valve Cv rating shall be as indicated. Valve operators shall be the electric type as indicated. Valves 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 and differential meter, suitable for the operating pressure specified. The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.9.2.9 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for 125 psig service, and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for 125 psig service.

2.9.2.10 Strainers

Strainers shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with

bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 62 per square centimeter 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.

2.9.2.11 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 a 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.

2.9.2.12 Pump Discharge Valves

Pump discharge valves shall be installed where indicated and shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valves shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Valves shall have an integral pointer which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. The valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. Valve Cv rating shall be as indicated.

2.9.2.13 Backflow Preventers

Backflow preventers shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

2.9.2.14 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 1048 kpa service as appropriate for the static head plus the system head, and 21 degrees C, 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.

2.9.2.15 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 with a range from 0 psig to approximately 1.5 times the maximum system working pressure.

2.9.2.16 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. Thermometers shall have rigid stems with straight, angular, or inclined pattern.

2.9.2.17 Pipe Nipples

Pipe nipples shall be in accordance with ASTM A 733 and be of material to match adjacent piping.

2.9.2.18 Pipe Unions

Pipe unions shall be in accordance with ASME B16.39 and be of material to match adjacent piping.

2.9.2.19 Solder

Solder for water piping shall be in accordance with ASTM B 32, alloy grade 50B.

2.9.3 Expansion Joints

2.9.3.1 Slip-Tube 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 traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 150 psig, and shall be in accordance with applicable requirements of EJMA-01 and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 5 mils of hard chrome in accordance with ASTM B 650. All joint components shall be suitable for the intended service. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer. Pipe alignment guides shall in no case be more than 5 feet from expansion joints except for pipe 4 inches or smaller. Pipe alignment guides on pipe 4 inches or smaller shall be installed not more than 2 feet from expansion joints. Service outlets shall be provided where indicated.

2.9.3.2 Flexible Ball Joints

Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 2 inches only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15 degree angular flex and 360 degree rotation. Ball and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with minimum 5 mils of hard chrome in accordance withEJMA-01 and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.9.3.3 Bellows Type Joints

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 ofEJMA-01 and ASME B31.1 with internal sleeves. 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 not less than 150 psig.

2.9.4 Refrigerant Piping and Fittings

Refrigerant piping, valves, fittings, and accessories shall conform to the requirements of ASHRAE 15 and ASME B31.5, except as specified.

2.9.4.1 Steel Pipe

Steel pipe for refrigerant service shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

2.9.4.2 Steel Pipe Joints and Fittings

Joints and fittings shall be steel butt-welding, socket-welding, or malleable iron threaded type. Pipe shall be welded except that joints on lines 2 inches and smaller may be threaded. Threads shall be tapered type conforming to ASME B1.20.1. The malleable iron threaded type fitting shall be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings shall be tongue-and-groove type with gaskets suitable for the refrigerant used; size 1 inch and smaller shall be oval, two-bolt type; size above 1 inch, up to and including 4 inches, shall be square four-bolt type; and sizes over 4 inches shall be round.

2.9.4.3 Steel Tubing

Steel tubing for refrigeration service shall be in accordance with ASTM A 334, Grade 1. Tubing with a nominal diameter of 3/8 inch or 1/2 inch shall have a wall thickness of 0.049 inches. Tubing with a nominal diameter of 3/4 inch through 2 inches shall have a wall thickness of 0.065 inches. Tubing with a nominal diameter of 2-1/2 inches through 4 inches shall have a wall thickness of 0.095 inches. Steel tubing shall be cold-rolled, electric-forged, welded-steel. One end of the tubing shall be provided with a socket. Steel tubing shall be cleaned, dehydrated, and capped.

2.9.4.4 Steel Tubing Joints and Fittings

Joints and fittings shall be socket type provided by the steel tubing manufacturer.

2.9.4.5 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared.

2.9.4.6 Copper Tube Joints and Fittings

Copper tube joints and fittings shall be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type

joints and fittings shall not be allowed for brazed joints.

2.9.5 Refrigerant Piping, Valves, and Accessories

Valves shall be pressure and temperature rates for contained refrigerant service and shall comply with ASME B31.5. Metals of constructions shall be ferrous or copper based. Atmosphere exposed valve stems shall be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves shall be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Ferrous body valves shall be fitted with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves shall be angle body type, and straight line valves shall be full port ball type. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Valves shall be cleaned and sealed moisture-tight.

2.9.5.1 Refrigerant-Stop Valves

Valves, in sizes through 16 mm, shall be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. In 16 mm sizes, valves shall be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shut-off valves shall have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves hall have back-seating plated steel stem, bolted bonnet in sizes 30 mm OD and larger, integral or flanged transition brazed socket. Valves in sizes through 64 mm shall be end-entry body assembly, full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 100 mm IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies shall be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-welded connection. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.9.5.2 Check Valves

Valve shall be designed for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 1/2 inch and larger. Valve shall provide positive shutoff at 10 kpa differential pressure.

2.9.5.3 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 700 kpa and a maximum operating pressure differential of at least 1397 kpa at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the

refrigerant used.

2.9.5.4 Expansion Valves

Expansion valves shall conform to requirements of ARI 750. Valve shall be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degrees C of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.9.5.5 Safety Relief Valves

Valve shall be two-way type. Single type valves shall be used only where indicated. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

2.9.5.6 Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

2.9.5.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.9.5.8 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.9.5.9 Sight Glass and Liquid Level Indicator

a. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

b. Gauge Glass: Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

c. Bull's-Eye and Inline Sight Glass Reflex Lens: Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

d. Moisture Indicator: Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.9.5.10 Vibration Dampeners

Dampeners shall be of the all-metallic bellows and woven-wire type.

2.9.5.11 Flexible Pipe Connectors

Connector shall be pressure and temperature rated for the service in accordance with ASHRAE 15 and ASME B31.5. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 degrees F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

2.9.5.12 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.9.5.13 Brazing Materials

Brazing materials for refrigerant piping shall be in accordance withAWS A5.8, Classification BCuP-5.

2.10 FABRICATION

2.10.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have

weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.10.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

2.10.2.1 Color Coding

Color coding for piping identification is specified in Section 09900 PAINTING, GENERAL.

2.10.2.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

2.11 FACTORY TESTS

2.11.1 Chiller Performance Test

The Contractor and proposed chiller manufacturer shall be responsible for performing the chiller factory test to validate the specified full load capacity, full load EER, and IPLV in accordance with ARI 550 except as indicated. The Contractor and chiller manufacturer shall provide to the Government a certified chiller factory test report in accordance with ARI 550 to confirm that the chiller performs as specified. All tests shall be conducted in an ARI certified test facility in conformance with ARI 550 procedures and tolerances, except as indicated. Tolerance or deviation shall not be allowed on chiller capacity or EER, IPLV. Stable operation at minimum load of 10 percent of total capacity shall be demonstrated during the factory test.

a. Temperature adjustments shall adhere to ARI 550 to adjust from the design fouling factor to the clean tube condition. Test temperature adjustments shall be verified prior to testing by the manufacturer. There shall be no exceptions to conducting the test with clean tubes with the temperature adjustments per section A7.3 of ARI 550. The manufacturer shall clean the tubes, if necessary, prior to testing to obtain a test fouling factor of 0.0000.

b. The factory test instrumentation shall be per ARI 550 and the calibration shall be traceable to the National Institute of Standards and Technology.

c. A certified test report of all data shall be forwarded to the Government for approval prior to project acceptance. All calibration curves and information sheets for all instrumentation shall be provided.

d. If the equipment fails to perform within allowable tolerances, the

manufacturer shall be allowed to make necessary revisions to his equipment and retest as required. The manufacturer shall assume all expenses incurred by the Government to witness the retest.

2.11.2 Chiller Sound Test

All centrifugal chillers shall be sound tested at the factory prior to shipment to confirm the sound pressure level specified below. All tests and data shall be conducted and measured in strict accordance with ARI 575. The centrifugal chiller sound pressure level, in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed 85 dB, A weighted, at full load. All ratings shall be in accordance with ARI 575. No reduction of entering condenser water temperature or raising of leaving chilled water temperature shall be allowed. A minimum of 75 percent of the sound data points shall be taken along the length of the machine, and established as the minimum percentage of total possible points used to determine sound levels. In the event that the chiller does not meet the dBA sound pressure level, the manufacturer shall, at his expense, provide sufficient attenuation to the machine to meet the specified value. This attenuation shall be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller. The attenuation material, adhesives, coatings, and other accessories shall have surface burning characteristics as determined byASTM E 84 not to exceed 25 for flame spread and 50 for smoke-development rating.

2.12 SUPPLEMENTAL COMPONENTS\SERVICES

2.12.1 Drain and Makeup Water Piping

Piping shall comply with the requirements of Section 15400 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer system shall be connected by means of an indirect waste.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPV VIII Div 1 and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPV VIII Div 1 and ASME BPV IX.

3.1.1 Refrigeration System

3.1.1.1 Equipment

Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, condensers, liquid coolers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed

between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators shall limit vibration to 30 percent at lowest equipment rpm. Lines connected to pumps 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 and concrete-structured or cased-cooling towers shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.1.2 Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system shall be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points shall be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 oz. of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

3.1.1.4 Automatic Controls

Automatic controls for the central refrigeration system specified in paragraph REFRIGERATION SYSTEM shall be provided with the central

refrigeration equipment. These controls shall operate automatically to balance the equipment capacity with the load on the air conditioning system, and shall be fully coordinated with and integrated into the temperature control system specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and 15951 DIRECT DIGITAL CONTROL FOR HVAC.

3.1.2 General Piping Installation

3.1.2.1 Brazed Joints

Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. All piping shall be supported prior to brazing and shall not be sprung or forced.

3.1.2.2 Threaded Joints

Threaded joints shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.2.3 Welded Joints

Welding shall be in accordance with qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Contracting Officer shall be notified 24 hours in advance of welding tests and the tests shall be performed at the work site if practical. A permanent mark shall be applied near each weld to structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL. Welded joints in steel refrigerant piping shall be fusion-welded. Changes in direction of piping shall be made with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Branch connections shall be made with welding tees or forged welding branch outlets. Steel pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.2.4 Flanged Joints

Flanged joints shall be faced true, provided with gaskets suitable for use with refrigerants and made square and tight. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items.

3.1.2.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.2.6 Thermometers

Thermometers shall be located specifically on, but not limited to the following: condenser water lines entering and leaving the condenser, the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof, the liquid line leaving receiver and the suction line at each evaporator or liquid cooler.

3.1.2.7 Supports

a. General: All refrigerant pipe supports shall be in accordance with ASME B31.5. 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.

b. Seismic Requirements: All piping and attached valves shall be supported and braced to resist seismic loads as specified under Section13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

c. Structural Attachments: Structural steel 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.

3.1.2.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 andMSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

c. C-Clamps: 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.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Saddles and Shields: Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

g. Horizontal Pipe Supports: 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. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

h. Vertical Pipe Supports: 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. Pipe Guides: 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.

j. Steel Slides: 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 shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

k. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, then 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.

l. 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 members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.2.9 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.2.10 Anchors

Anchors shall be provided wherever necessary or indicated 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. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.2.11 Pipe Sleeves

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, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed as indicated and specified in Section 07920 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed.

a. Roof and Floor Penetrations: Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and 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 troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above highest floor level of the roof or a minimum of 10 inches above the roof, whichever is greater, or 10 inches above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. 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. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a

waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of 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. 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 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. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.2.12 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.1.2.13 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, 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 Water Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.1.3.1 Directional Changes

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 weep 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.

3.1.3.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt

or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances 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 and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.3.3 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.3.4 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.3.5 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.3.6 Flexible Pipe Connectors

Preinsulated flexible pipe connectors shall be attached to other components in strict 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 flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.3.7 Flanges and Unions

Except where copper tubing is used, union or flanged 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.

3.1.3.8 Grooved Mechanical Joints

Grooves shall be prepared in accordance with 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 pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.1.4 Refrigeration Piping

Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made.

3.1.4.1 Directional Changes

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, or other malformations will not be accepted.

3.1.4.2 Functional Requirements

All piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.1.4.3 Valves

a. Stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Angle and globe valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. All valves except check valves shall be identified with a brass or aluminum tag not less than 1-3/8 inch in diameter, correctly stamped to explain the valve function, and with a number for identification. Tags shall be secured to the valve with No. 12 AWG copper wire.

b. Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.4.4 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.1.4.5 Strainers

Strainers shall be provided immediately ahead of all solenoid valves and expansion devices. Strainers may be an integral part of the expansion valve.

3.1.4.6 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. The filter dryer shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. The filter dryer shall be installed such that the filter dryer can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Filter dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.4.7 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers.

3.1.4.8 Discharge Line Oil Separator

Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

3.1.4.9 Accumulator

Accumulators shall be provided in the suction line to each compressor.

3.1.5 Mechanical Room Ventilation

Mechanical rooms containing a central refrigerated air-conditioning system shall be ventilated to the outdoors. The ventilation system shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.6 Field Applied Insulation

Field applied insulation other than that specified for water boxes and headers shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.7 Factory Applied Insulation

3.1.7.1 Refrigerant Suction Lines

Refrigerant suction lines between the cooler and each compressor shall be insulated with not less than 3/4 inch thick unicellular plastic foam.

3.1.7.2 Liquid Coolers

Liquid coolers (including chilled water headers or boxes), which may have factory or field applied insulation, shall be insulated with unicellular plastic foam. Insulation shall be not less than 3/4 inch thick or have a

maximum thermal conductivity of 0.28 Btu/(hr.)(sq. ft.)(degree F.))). In lieu of the above insulation, a 2 inch thickness of urethane foam may be used. Urethane foam shall be completely covered and sealed with a sheet metal jacket not lighter than 20 gauge. Insulation on heads of coolers shall be constructed to provide easy removal and replacement of heads without damage to the insulation.

3.2 TESTS

3.2.1 Field Tests

Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.2.1.1 Water Pipe Testing

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 shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

3.2.1.2 Refrigerant Pipe Testing

a. Refrigerant Leakage Test: After all components of the refrigerant system have been installed and the piping connected, the system shall be subjected to a refrigerant leakage test. The refrigerant leakage test shall be done with dry nitrogen before any refrigerant pipe is insulated or covered. High and low side of the refrigerant system shall be tested for the minimum refrigerant leakage test pressure specified in ASHRAE 15, for the refrigerant employed in the system. System shall be proved tight and free of leaks by allowing the refrigerant leakage test pressure to remain on the system for 24 hours with no drop in pressure. The initial test pressure and surrounding air temperature will be recorded. After the 24 hour hold period, the final system pressure and surrounding air temperature will be recorded. A correction of 0.3 psi shall be allowed for each degree F change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. The system shall have passed the refrigerant leakage test if the corrected final system pressure is equal to the initial system test pressure. If the pressures are not equal, the leaks shall be located and repaired.

b. Refrigerant Leaks: To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. Joints repaired by caulking or remelting and adding more brazing material will not be acceptable. After leak repairs have been made, the refrigerant leakage test shall be conducted again.

c. Evacuation Test: After the foregoing tests have been

satisfactorily completed and the pressure relieved, entire system shall be evacuated to an absolute pressure of 300 microns. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. Vacuum line shall be closed, and the system shall stand for 1 hour. After this period, the absolute pressure shall not exceed 500 microns. If the pressure rises over 500 microns, the system shall continue to be evacuated until the system reaches 300 microns and can stand for 1 hour with the vacuum line closed without the absolute pressure rising over 500 microns. During evacuation, pressures shall be recorded by a thermocouple type, electronic type, or a calibrated-micron type gauge.

3.3 INSPECTIONS

At the conclusion of the one year period, the cooling tower and condenser shall be inspected for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturers recommended conditions, 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.

3.4 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 1 day. The representative shall advise on the following:

a. Hermetic machines:

(1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

(3) Starting the machine.

b. Absorption Units:

(1) Testing and evacuation.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

3.5 CLEANING AND ADJUSTING

3.5.1 Piping

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all 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 all 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.

3.5.2 Equipment

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. 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 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and 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 Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

END OF SECTION

-- End of Section --

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SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

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	(1990) Air Terminals
ARI Guideline D	(1987) Application and Installation of Central Station Air-Handling Units

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1993) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181	(1995b) Forgings, Carbon Steel, for General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193	(1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234	(1996) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 924	(1994) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings of Ferrous Substrates
ASTM C 916	(1985; R 1990) Adhesives for Duct Thermal Insulation
ASTM C 1071	(1991) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1989) Zinc Dust Pigment
ASTM D 1785	(1994) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2466	(1994a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1993) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3359	(1995) Measuring Adhesion by Tape Test
ASTM E 84	(1994) Surface Burning Characteristics of Building Materials
ASTM E 437	(1992) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM F 872	(1984; R 1990) Filter Units, Air-Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 1199	(1988; R 1993) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

ASTM F 1200	(1988; R 1993) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
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 Rating the Performance of Air Outlets and Inlets

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
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	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1995) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419	(Rev D) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA-01	(1993) EJMA Standards

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1991) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code
NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA-01	(1993) Fibrous Glass Duct Construction Standards

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-05	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA-06	(1995) HVAC Duct Construction Standards - Metal and Flexible
SMACNA-10	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL-01	(1996; Supple) Building Materials Directory
UL-03	(1996; Supple) Electrical Construction Materials Directory
UL-05	(1996; Supple) Fire Resistance Directory (3 Vol.)
UL 181	(1996; Rev Oct 1996) Factory-Made Air Ducts and Air Connectors
UL 214	(1993) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1995) Fire Dampers
UL 723	(1993; Rev Apr 1994) Test for Surface Burning Characteristics of Building Materials
UL 900	(1994) Test Performance of Air Filter Units
UL 1995	(1995) Heating and Cooling Equipment

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 "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Components and Equipment Data; FIO.

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

e. Energy Recovery Devices

f. Terminal Units

SD-04 Drawings

Air Supply, Distribution, Ventilation, and Exhaust Equipment; FIO.

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-06 Instructions

Test Procedures; FIO.

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; FIO.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; FIO.

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.

SD-07 Schedules

Test Schedules; FIO.

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 Schedule; FIO.

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-08 Statements

Similar Services; FIO.

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 Qualification; FIO.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

SD-09 Reports

Test Reports; FIO.

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-13 Certificates

Bolts; FIO.

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-19 Operation and Maintenance Manuals

Air Supply, Distribution, Ventilation, and Exhaust Manuals; FIO.

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 8 hour 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. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed according to Section 05500 MISCELLANEOUS METAL.

2.5 PIPING COMPONENTS

2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Grade A or B, Type E or S.

2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 1 inch and smaller shall be threaded; piping larger than 1 inch and smaller than 3 inches shall be either threaded, grooved, or welded; and piping 3 inches and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the

circulating medium does not exceed 230 degrees F. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181 and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to 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). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193.

2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

2.5.2.4 Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

2.5.2.5 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 125 psig service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B orASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.5.3 Copper Tube

Copper tube shall conform to ASTM B 88, Type K or L.

2.5.4 Joints and Fittings For Copper Tube

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. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing 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.

2.5.5 Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 10 feet or higher above the floor. Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.5.5.1 Gate Valves

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, solder, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70 and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.5.5.2 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 toMSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.3 Check Valves

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 3 inches and larger shall conform to MSS SP-71 and shall be cast iron with bronze trim and flanged or threaded ends.

2.5.5.4 Angle Valves

Angle valves 2-1/2 inches and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Angle valves 3 inches and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.5 Ball Valves

Ball valves 1/2 inch and larger shall conform to MSS SP-72, and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

2.5.5.6 Butterfly Valves

Butterfly valves shall be 2 flange or lug wafer type, and shall be bubble-tight 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.

2.5.5.7 Balancing Valves

Balancing valves 2 inches or smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 1 inch or larger may be all iron with threaded or flanged ends. The valves shall have a square head or similar device and an indicator arc and shall be designed for 250 degrees F. Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug valves. In lieu of plug valves, ball valves may be used. Plug valves and ball valves 8 inches or larger shall be provided with manual gear operators with position indicators. In lieu of balancing valves specified, 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 psig or 150 percent of the system operating pressure, whichever is the 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 appropriately increased. Where flow readings are provided by remote or portable meters, 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 furnished with accessory kit as recommended by the automatic valve manufacturer shall be provided. Automatic flow control valve specified may be substituted for venturi tubes or orifice plate flow measuring devices.

2.5.5.8 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for pressure rating of piping system and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for pressure rating of piping system.

2.5.6 Strainers

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 22 gauge brass sheet, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3,300 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.7 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 15650 CENTRAL REFRIGERATED AIR CONDITIONING SYSTEM.

2.5.8 Water or Steam Heating System Accessories

Water or steam heating accessories such as expansion tanks and steam traps shall be as specified in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

2.5.9 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

2.5.10 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.

2.5.11 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.

2.5.12 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.

2.5.13 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.

2.5.14 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 andMSS SP-69.

2.5.15 Expansion Joints

2.5.15.1 Slip 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 traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 150 psig, and shall be according to applicable requirements of EJMA-01 and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joint shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 2 mils of hard chrome according to ASTM B 650. All joint components shall be suitable for the intended service. Initial setting shall be made according to the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 5 feet from expansion joint except that 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.

2.5.15.2 Flexible Ball Joints

Flexible ball joints shall conform to EJMA-01 and ASME B31.1 and be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 2 inches only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360 degree rotation. Balls and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with mils of hard chrome according to ASTM B 650. The ball type joints shall be designed and constructed according to EJMA-01 and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.5.15.3 Bellows Type Joints

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 ofEJMA-01 with internal sleeves. Guiding of piping on both sides of expansion joint shall be according to 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 not less than 150 psig.

2.5.16 Insulation

Shop and field applied insulation shall be as specified in Section15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.5.17 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.

2.7 DUCTWORK COMPONENTS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA-06 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 15250 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-06. 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.

2.7.1.1 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.

2.7.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply galvanized steel. 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.

2.7.1.3 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 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.7.1.4 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-01.

2.7.2 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-01 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 15250 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 byNAIMA-01, 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.

2.7.3 Ductwork Accessories

2.7.3.1 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 toSMACNA-06. 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.

2.7.3.2 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. 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-05. Fire dampers shall be curtain type with damper blades in the air stream. 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-05 and in manufacturer's instructions for fire dampers shall be followed.

2.7.3.3 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.

2.7.3.4 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.

2.7.4 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.7.4.1 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, 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.

2.7.4.2 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.

2.7.4.3 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.

2.7.5 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 toASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15250 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-06. 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.

2.7.6 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.

2.7.6.1 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-03 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.

2.7.6.2 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.

2.7.7 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.

2.7.8 Air Vents, Penthouses, and Goosenecks

Air vents, penthouses, and goosenecks shall be fabricated from galvanized steel sheets with galvanized structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform toSMACNA-06. 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.

2.7.9 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Frames shall be removable type or stainless steel or extruded aluminum.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Fans

2.8.1.1 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 ABEMA 9 and ABEMA 11. Motors shall have dripproof enclosure. Motor starters shall be across-the-line with general-purpose enclosures. Remote manual switch with pilot indicating light shall be provided where indicated.

2.8.1.2 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.

2.8.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper tubes and aluminum 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. 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.

2.8.2.1 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.

2.8.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.8.3.1 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.

2.8.3.2 Extended Surface Nonsupported Pocket Filters

Filters shall be 30 inch depth, sectional, replaceable dry media type of the size indicated and shall have an average efficiency of 80 to 85 percent when tested according to ASHRAE 52.1. Initial resistance at 500 feet per minute shall not exceed 0.45 inches water gauge. Filters shall be UL Class 1. Media shall be fibrous glass, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Pockets shall not sag or flap at anticipated air flows. Each filter shall be installed [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.8.3.3 Replaceable Media Filters

Replaceable media filters shall be the viscous adhesive type, of the size required to suit the application. Filtering media shall be not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 16 gauge galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding 300 feet per minute, with initial resistance of 0.13 inches water gauge. Average efficiency shall be not less than 80 percent when tested according to ASHRAE 52.1.

2.8.3.4 Holding Frames

Frames shall be fabricated from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

2.8.3.5 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, shall have white dials with black figures, and graduations shall have a minimum range of 1 inch beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter aluminum tubing, and all hardware and accessories for gauge mounting.

2.9 AIR HANDLING UNITS

2.9.1 Factory-Fabricated Air Handling Units

Units shall be single-zone draw-through type as indicated. Units shall

include fans, coils, airtight insulated casing, prefilters, adjustable V-belt drives, access sections where indicated, mixing box, combination sectional filter-mixing box, spray type humidifier, 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.

2.9.1.1 Casings

Casing sections shall be 2 inch double wall type 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. A minimum 8 inches by 8 inches sealed glass window suitable for the intended application shall be installed in all access doors. 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 15250 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 ofASTM 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.

2.9.1.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

2.9.1.3 Cooling Coils, Spray Type

Cooling coils shall be of the copper finned water type as specified in paragraph AIR SYSTEMS EQUIPMENT furnished complete with water sprays. All horizontal units and vertical units with coil face velocities of 550 fpm or above, shall be provided with moisture eliminators. Sprays shall have all bronze, brass, or stainless steel centrifugal type nozzles, with removable caps designed and arranged for uniform wetting of the entire coil face area. Nozzles shall be supplied by standard weight galvanized steel piping and a centrifugal type circulating pump furnished as an integral part of the unit. Eliminators shall be not lighter than 24 gauge corrosion-resistant steel, removable for maintenance and coil inspection. No water shall carry over into the fan section or supply ducts from the air handling unit provided with or without eliminators.

2.9.1.4 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.9.1.5 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 byABEMA 9 and ABEMA 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 splashproof enclosures. Motor starters shall be across-the-line 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.

2.9.1.6 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.

2.9.1.7 Dampers

Dampers shall be as specified in paragraph CONTROLS.

2.10 TERMINAL UNITS

2.10.1 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. Unit volume controller shall be normally open upon loss of pressure.

2.10.1.1 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.

2.11 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123 or ASTM A 924 shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatised 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 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. 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. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inch or less in diameter, and with flanges for pipe 3 inches and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.1.1 Joints

a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

b. Soldered Joints: Joints in copper tubing shall be cut square with ends reamed, and all filings and dust wiped from interior of pipe. Joints shall be soldered with 95/5 solder or brazed with silver solder applied and drawn through the full fitting length. Care shall be taken to prevent annealing of tube or fittings when making connections. Joints 2-1/2 inch and larger shall be made with heat uniformly around the entire circumference of the joint with a multi-flame torch. Connections in floor slabs shall be brazed. Excess solder shall be wiped from joint before solder hardens.

c. Welded Joints: Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. Structural members shall be welded according to Section 05055 WELDING, STRUCTURAL. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld. Welded joints shall be fusion welded unless otherwise required. 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 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. Electrodes shall be stored and dried according toAWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.1.2 Grooved Mechanical Joints

Grooves 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 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.

3.1.1.3 Flanges and Unions

Except where copper tubing is used, union or flanged 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.

3.1.2 Supports

3.1.2.1 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.

3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STEEL JOISTS.

3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 andMSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: 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.

c. C-Clamps: 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.

d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Type 39 saddles shall be used on all insulated pipe 4 inches and larger when the temperature of the medium is above 60 degrees F. Type 39 saddles shall be welded to the pipe.

g. Type 40 shields shall:

(1) be used on all insulated pipes less than 4 inches.

(2) be used on all insulated pipes 4 inches and larger when the temperature of the medium is 60 degrees or less.

(3) have a high density insert for pipe 2 inches and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or when the insulation or jacket shows visible signs of distortion at or near the type 40 shield. High density inserts shall have a density of 9 pcf or greater.

h. Horizontal Pipe Supports: 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. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

i. Vertical Pipe Supports: 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.

j. Pipe Guides: 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.

k. Steel Slides: 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 with medium 60 degrees F or greater, a Type 39 saddle may be welded to the pipe and freely

rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

l. High Temperature Guides with Cradles: 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.

m. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.3 Anchors

Anchors shall be provided wherever necessary or indicated 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.

3.1.4 Pipe Sleeves

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, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07920 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

3.1.4.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and 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 troweled coating of bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 2 inches above highest floor level or a minimum of 10 inches above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing

sleeve and the metal-jacket-covered insulation shall be sealed as indicated. 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. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of 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. 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.

3.1.4.2 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

3.1.4.3 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.

3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units. [units except room fan-coil units and coil-induction units. The depth of each seal shall be 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.7 Air Vents and Drains

3.1.7.1 Vents

Air vents shall be provided at high points, on water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7.2 Drains

Drains shall be provided at low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment such as pumps, heaters, heating or cooling coils, and other similar items, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purposes. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.9 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.

3.1.10 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.

3.1.11 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.

3.1.12 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 07270 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07920 JOINT SEALING.

3.1.13 Metal Ductwork

Installation shall be according to SMACNA-06 unless otherwise indicated. Duct supports for sheet metal ductwork shall be according toSMACNA-06, unless otherwise specified. Friction beam clamps indicated in SMACNA-06 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.

3.1.13.1 Light Duty Corrosive Exhaust Ductwork

Light duty corrosive exhaust ductwork shall be PVC plastisol coated galvanized steel with PVC coating on interior and exterior surfaces.

3.1.14 Fibrous Glass Ductwork

Installation shall be according to the manufacturer's written recommendations unless otherwise required in NAIMA-01. Duct supports for fibrous glass ductwork shall conform to NAIMA-01. In those cases not covered in NAIMA-01, the written recommendation of the fibrous duct manufacturer shall be followed.

3.1.15 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-06. 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-06 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

3.1.16 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.

3.1.17 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15250 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.

3.1.18 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.

3.1.19 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 PIPING IDENTIFICATION

Finish painting of items only primed at the factory or surfaces not specifically noted otherwise and identification for piping are 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, filters, etc. designated as static pressure Class 3 inch water gauge through Class 10 inch water gauge. Test procedure, apparatus, and report shall conform to SMACNA-10. The maximum allowable leakage rate is 10% of the total air volume. 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 Section15990 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 2 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 -- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15951

DIRECT DIGITAL CONTROL FOR HVAC

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SECTION 15951

DIRECT DIGITAL CONTROL FOR HVAC

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 500	(1989) Test Methods for Louvers, Dampers and Shutters

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.154	(1988; R 1994) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269	(1994a) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 635	(1991) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 1693	(1994) Environmental Stress-Cracking of Ethylene Plastics

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-03	(1993) Handbook, Fundamentals I-P Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic

	Coverage
ASME PTC 19.3	(1974; R 1986) Instruments and Apparatus: Part 3 Temperature Measurement

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices
47 CFR 68	Connection of Terminal Equipment to the Telephone Network

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) 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 Controls and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-07	(1993) HVAC Systems - Testing, Adjusting and Balancing

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 555S	(1996) Leakage Rated Dampers for Use in Smoke-Control Systems
UL 916	(1994; Rev thru May 1996) Energy Management 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.

All building DDC for HVAC equipment shall be integrated with the existing base wide EMCS (Energy Management and Control System) using one of the three following manufacturers:

HSQ:
HSQ Technology (Attn: Chris Sorenson)
1435 Huntington Avenue
South San Francisco, CA 94083
1-800-486-6684

Alerton:
ACX Technologies (Attn: Todd Madison)
PO Box 6210
Fresno, CA 93703
(209) 498-3965

Omega Controls (Attn: John Murray)
7920 Arjons Drive #F
San Diego, CA 92126
(619) 695-6771

Zeta:
R.P. Richards
Electronics Division (Attn: Thomas Breen)
Goleta, CA 93117
(805) 683-6683

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. Nameplates shall be mechanically attached to Direct Digital Control (DDC) panel interior doors. 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

The Contractor shall become familiar with all details of the work, 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 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 8 microsecond by 20 microsecond waveform with a peak voltage of 1,000 volts and a peak current of 500 amperes.

1.2.6 Power-Line Conditioners (PLC)

PLCs 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 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 two cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

1.2.7 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 panel 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.

1.2.8 Multiple DDC Panel Requirement

Where the system to be controlled by the DDC system is located in multiple mechanical rooms, each mechanical room shall have at least one DDC panel. DDC panels shall not control equipment located in a different mechanical room. DDC panels 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.

1.2.9 System Accuracy and Display

The system shall maintain an end-to-end accuracy for 1 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.

1.2.9.1 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.

1.2.9.2 Duct Temperature

Duct temperature with a range of 40 to 140 degrees F plus or minus 2 degrees F.

1.2.9.3 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.

1.2.9.4 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 degrees F using matched sensors.

1.2.9.5 High Temperature

High temperature with a range of 200 to 500 degrees F plus or minus 2.0 degrees F.

1.2.9.6 Relative Humidity

Relative humidity with a range of 20 to 80 percent plus or minus 6.0 percent of range (display and print to nearest 1.0 percent).

1.2.9.7 Pressure

Pressure with a range for the specific application plus or minus 2.0 percent of range (display and print to nearest psi.

1.2.9.8 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).

1.2.9.9 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).

1.2.9.10 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 "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Data; FIO.

The equipment data shall be in booklet form, indexed to the unique identifiers, shall consist of data sheets that document compliance with the specification and shall include a copy of each HVAC control system bill of materials. Catalog cuts shall be in booklet form indexed by device type. Where multiple components are shown on a catalog cut, the application specific component shall be marked. Data shall include a list of qualified service organizations and their qualifications. Service organizations shall be reasonably convenient to the equipment on a regular and emergency basis, during the warranty period.

System Descriptions and Analyses; FIO.

System descriptions, analyses, and calculations used in required sizing equipment. Descriptions and calculations shall show how the equipment will operate as a system to meet the specified performance. The data package shall include the following:

a. DDC panel memory size.

b. DDC panel automatic start up operations.

c. Database update procedure.

d. DDC panel expansion capability and method of implementation.

e. DDC panel operation.

f. Database entry forms or data listings.

Software; FIO.

Descriptions of software, including the control algorithm for PID control and explanation as required.

System Overall Reliability Calculations; FIO.

Manufacturer's reliability data and calculations required to show compliance with the specified reliability. Instrumentation and controls shall not be included in the calculations.

Training Data; GA.

A training course in the maintenance and operation of the HVAC control systems, approved 60 days prior to the start of training. Lesson plans and training manuals for the training, including type of training to be provided, with a list of reference material. The training shall be oriented to the specific systems being installed. One training manual shall be furnished for each trainee, plus two additional copies for archival storage at the project site. The manuals shall include the agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Two copies of audiovisual materials shall be included, for archival storage at the project site, either as a

part of the printed training manuals or on the same media as that to be used during the training session.

Data Entry Forms; GA.

The completed data entry forms or data summaries, if data entry is done through interactive computer interfacing, utilizing all data required by the contract documents and other pertinent information required for complete installation of the database. Additional data to provide a complete and operational control system shall be identified and requested from the Government. The proposed forms shall be provided at least 90 days prior to the Contractor's scheduled need date.

SD-04 Drawings

System Drawings; FIO.

The system drawings shall include the following:

a. A drawing index.

b. A list of symbols.

c. A series of drawings for each HVAC control system using abbreviations, symbols, nomenclature and identifiers as shown on the contract drawings. Each control-system element on a drawing shall have a unique identifier as shown.

Each series of drawings for an HVAC control system shall include a schematic as shown on the contract drawings, a wiring diagram, a list of equipment with manufacturer and model number, a DDC panel arrangement drawing and an HVAC control-system sequence of operation. The sequence of operation for each HVAC control system shall be in the language and format of this specification. No operational deviations from specified sequences will be permitted without prior written approval of the Contracting Officer. The sequence of operation shall refer to each device by its unique identifier.

The wiring diagram shall show the interconnection of wires and cables to DDC panel terminal blocks and to the identified terminals of starters and packaged equipment, with all necessary jumpers and ground connections. The wiring diagram shall show the labels of all conductors. All sources of power required for HVAC control systems and for packaged equipment control systems shall be identified back to the panelboard circuit breaker number, DDC panel, magnetic starter, or packaged control equipment circuit. Each power supply and transformer not integral to a starter or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

d. A system block diagram.

e. DDC panel/DTC installation, block diagrams, and wiring diagrams.

f. DDC panel/DTC physical layout and schematics.

g. Details of surge protection device installations.

h. Valve schedules.

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, and actuator size, supported by close-off pressure data, dimensions, operation rate, and access and clearance requirements data.

i. Damper schedules.

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 multisection dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum expected velocity through the damper at the intended location and 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; and access and clearance requirements.

j. Compressed-air station schematic on 34 by 22 inch sheets.

The compressed-air station schematic diagram shall show all equipment, including compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturers' names and model numbers, mounting, access, and clearance requirements. Air compressor and air dryer data shall include calculations of the air consumption of current-to-pneumatic transducers (EPs) and of any other control system devices to be connected to the compressed-air station, the number of starts per hour and the running time for the unit selected, and the compressed air supply dewpoint temperature at 20 psig.

k. ASME air storage tank certificate.

SD-08 Statements

Factory Testing; GA.

Six copies of the test procedures for the factory test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the specified requirements, and the methods for simulating the necessary conditions of operation to demonstrate performance of the system. Written approval by the Government of the factory test procedures shall be one of the prerequisites for scheduling the factory test.

Site Testing; GA.

Six copies of the test procedures for the site testing. The site testing procedures shall identify each item to be tested and shall clearly describe each test. The test procedures shall include a list of the test equipment to be used for site testing, manufacturer and model number, and the date of calibration and accuracy of calibration, within 6 months of the test date.

Performance Verification Testing and Endurance Testing; FIO.

Six copies of the test procedures for the performance verification test and the endurance test. The test procedures shall explain in detail,

step-by-step actions and expected results to demonstrate compliance with the specified requirements. Written approval by the Government of the performance verification test procedures shall be one of the prerequisites for commencing the performance verification test.

Commissioning Procedures; FIO.

Commissioning procedures for each HVAC control system, and for each type of terminal unit control system. The procedures shall reflect the language and format of this specification. The commissioning procedures shall refer to the devices by their unique identifiers as shown and shall include step-by-step configuration procedures for each system. The configuration procedures shall include a configuration check sheet showing all configuration parameters.

Six copies of Commissioning Procedures, in booklet form and indexed, for each system, 60 days prior to system commissioning. Commissioning procedures shall include general instructions on how to set control parameters including setpoints; proportional, integral, and derivative mode constants; contact output settings for the specific devices provided. Commissioning procedures shall be specific to each HVAC system, shall detail the steps involved, and shall refer to the procedures in the booklet for specific devices.

SD-09 Reports

Test Reports; FIO.

Six copies of the site testing data. Original copies of all data produced during site testing, including results of each test procedure, after approval of the site tests.

Performance Verification and Endurance Report; FIO.

Six copies of the performance verification and endurance test report after completion of a successful test.

Documentation of test results for the entire HVAC control system complete, in booklet form and indexed, within 30 days after each test.

Control System Calibration, Adjustments, and Commissioning; FIO.

Six copies of the calibration, adjustment and commissioning report which shall include setpoints and proportional, integral and derivative mode constant settings, calibration data for all instruments and controls, and all the data resulting from adjusting the control system devices and commissioning HVAC control system.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manuals; FIO.

The Group III Technical Data Package consisting of the operation and maintenance data in manual format. Final copies of the manuals bound in hardback, loose leaf binders, within 30 days after completing the endurance test. 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. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and

telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The draft copy used during site testing shall be updated with any changes required, prior to final submission of the manual. The final copies delivered after completion of the endurance test shall include modifications made during installation checkout and acceptance. Manuals shall include:

Functional Design Manual; FIO.

Two copies of the functional design manual which 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.

Hardware Manual; FIO.

Two copies of the hardware manual which shall describe equipment furnished, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. System schematics and I/O device wiring lists.

e. Alignment and calibration procedures.

f. Manufacturer's repair parts list indicating sources of supply.

Software Manual; FIO.

Two copies of the software manual which shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation including, but not limited to the following:

a. Definitions of terms and functions.

b. Operator commands.

c. System access requirements.

d. Data entry requirements.

e. Descriptions of application software.

f. Description of database structure and interface with programs.

g. Alarms.

Operator's Manual; FIO.

Six complete copies of operation manuals for each HVAC control system, in booklet form and indexed, outlining the step-by-step procedures required for each HVAC control system's startup, operation, and shutdown. The

manuals shall include all detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment.

Maintenance Manual; FIO.

Six complete copies of maintenance manuals, indexed in booklet form listing maintenance procedures. The maintenance instructions shall include a maintenance check list for each HVAC control system. Maintenance manuals shall include spare parts data and recommended maintenance tool kits for all control devices. Maintenance instructions shall include recommended repair methods, either field repair, factory repair, or whole-item replacement. The manual shall contain a list of service organizations qualified to service the HVAC control system, including the service organization name and telephone number. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

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 TESTING

1.5.1 Factory Test

The Contractor shall assemble the factory test DDC system as specified and perform test to demonstrate that the performance of the system satisfies the requirements of this specification. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced, including results of each test procedure during factory testing shall be delivered to the Government at the conclusion of testing, prior to Government approval of the test. The test results documentation shall be arranged so that all commands, responses, and data acquired are correlated in a manner which will allow for logical interpretation of the data. The factory test setup shall include the following:

a. Command Entry Device with Keyboard.

b. Printer.

c. Disk Storage.

d. DDC Panel.

e. DDC Panel Test Set.

f. DDC Panel Portable Tester.

g. VAV Box Controller.

h. VAV Box Communication and Programming Device.

i. Communication links of each type and speed including Modems.

j. Dial-up Modem.

k. Software.

1.5.2 Site Testing

Personnel, equipment, instrumentation, and supplies shall be provided as necessary to perform site testing, adjusting, calibration and commissioning. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. Written Government approval of the specific site testing procedures shall be obtained prior to any test. Written notification of any planned site testing, commissioning or tuning shall be given at least 14 calendar days prior to any test.

1.5.3 Control System Calibration, Adjustments, and Commissioning

Instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. 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. Control system commissioning shall be performed for each HVAC system. The report describing results of functional tests, diagnostics, and calibrations, including written certification, shall state 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.

1.5.4 Performance Verification Test

Compliance of the HVAC control system with the contract documents shall be demonstrated. Using test plans and procedures previously approved, physical and functional requirements of the project, including communication requirements shall be demonstrated. The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt of written permission by the Government, based on the Contractor's written certification of successful completion of site testing and training.

1.5.5 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.

1.5.6 Coordination with HVAC System Balancing

The HVAC control system shall be tuned after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report issued. Commissioning may be performed prior to or simultaneous with HVAC system balancing.

1.5.7 Posted Instructions

Instructions on letter-size sheets and half-size plastic laminated drawings for each system, showing the final installed conditions, shall be placed in each HVAC control panel. The posted instructions shall include the control sequence, control schematic, ladder diagram, wiring diagram, valve schedules, damper schedules, commissioning procedures, and preventive maintenance instructions.

1.6 TRAINING

1.6.1 General

The training course shall be conducted for 8 operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. A training day is defined as 8 hours of classroom instruction, including breaks and 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 the attendees will have a high school education or equivalent, and are familiar with HVAC systems. No training shall be scheduled until training manuals and O&M manuals have been approved by the Government.

1.6.2 Training Course Content

The course shall be taught at the project site for a period of 4 training days. The training course shall cover all 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 system-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.

1.7 MAINTENANCE AND SERVICE

1.7.1 General Requirements

Services, materials and equipment shall be provided as necessary to maintain the entire system in an operational state as specified for a period of 1 year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized.

1.7.2 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.

1.7.3 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.

1.7.4 Scheduled Inspections

Two inspections shall be performed at 6 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 all equipment.

b. Fan checks and filter changes for all control system equipment.

c. Clean all 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 all system software diagnostics and correct all diagnosed problems.

f. Resolve any previous outstanding problems.

1.7.5 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays.

1.7.6 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 3 calendar days after receiving a request for service.

1.7.7 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

1.7.8 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 all initial analog span and zero calibration values and all 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.

1.7.9 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.

1.7.10 System Modifications

Recommendations for system modification shall be submitted in writing. System modifications, including operating parameters and control settings, shall not 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.

1.7.11 Software

Updates to the software shall be provided for system; operating and application software shall be updated 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

The equipment 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 the other information technology properly exchanges date/time data with it.

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 2 years prior to use on this project. The 2 years use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 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 2 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. No pneumatics will be allowed.

2.1.1 Electrical and Electronic Devices

Electrical, electronic, and electropneumatic devices not located within an HVAC control panel shall have a NEMA ICS 1 enclosure in accordance withNEMA 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 panels shall be 4-to-20 mAdc 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 plus 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 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.

2.2 TUBING

2.2.1 Copper

Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves.

2.2.2 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269 and shall have stainless steel compression fittings.

2.2.3 Plastic

Plastic tubing shall have barbed fittings and valves. Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

2.3 WIRING

2.3.1 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.

2.3.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum and shall be rated for 300-volt service.

2.3.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 14 AWG minimum and shall be rated for 600-volt service.

2.3.4 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.

2.4 ACTUATORS

2.4.1 General Requirements

Actuators shall be electric or electronic as shown. Actuators shall fail to their spring-return positions on signal or power failure and shall have

a visible position indicator. Actuators shall open or close the devices to which they are applied within 60 seconds after a full scale input signal change. Electric or electronic actuators operating in parallel or in sequence shall have an auxiliary actuator driver.

2.4.2 Damper Actuators

The actuators shall be provided with mounting and connecting hardware. Actuators shall smoothly operate the devices to which they are applied. Actuators shall fully open and close the devices to which they are applied and shall have a full stroke response time of 60 seconds or less. The actuator stroke shall be limited by an adjustable stop in the direction of power stroke.

2.4.3 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.

2.5 AUTOMATIC CONTROL VALVES

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. 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.

2.5.1 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 20 to 250 degrees F. Valves shall have a manual means of operation independent of the actuator.

2.5.2 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

2.5.3 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

2.5.4 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.

2.5.5 Valves for Chilled Water, Condenser Water, and 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.

2.5.6 Valves for Hot Water and Dual Temperature Service

For hot water service below 250 degrees F and Dual Temperature Service, 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 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.

2.5.7 Valves for High-Temperature Hot Water Service

For high-temperature hot water service above 250 Degrees F, valve bodies shall be rated ANSI Class 300, as specified in ASME B16.34. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 1 inch and larger. Valves smaller than 1 inch shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Internal valve trim shall be Type 316 stainless steel. Valve Cv shall be within 100 to 125 percent of the Cv shown.

2.6 DAMPERS

2.6.1 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 500.

2.6.2 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.

2.6.3 Damper Types

Dampers shall be parallel blade type.

2.6.3.1 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 degrees F to 200 degrees F. Dampers shall be rated at not less than 2,000 feet per minute air velocity.

2.6.3.2 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 per 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.

2.6.3.3 Smoke Dampers

Smoke damper and actuator assembly required per NFPA 90A shall meet the Class II leakage requirements of UL 555S. Dampers shall be rated at not less than 2000 feet per minute air velocity.

2.6.4 Damper End Switches

Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.7 SMOKE DETECTORS

Smoke detectors shall be as specified in Section 16721 FIRE DETECTION AND ALARM SYSTEM.

2.8 INSTRUMENTATION

2.8.1 Measurements

Each transmitter shall have offset and span adjustments. Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for a linear 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 except that return air temperature for economizer operation shall be minus 30 to plus 130 degrees F.

c. High temperature hot water, 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 100 to 250 degrees F.

g. Condenser water temperature, from 30 to 130 degrees F.

h. Outside air temperature, from minus 30 to plus 130 degrees F.

i. Relative humidity, 0 to 100 percent for high limit applications; from 20 to 80 percent for space 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 500 to 1,200 fpm; 0 to 0.25 inch water gauge for velocities of 500 to 1,800 fpm; or 0 to 0.5 inch water gauge for velocities of 500 to 2,500 fpm.

l. Electronic air flow measurement station and transmitter, from 125 to 2,500 fpm.

2.8.2 Temperature Instruments

2.8.2.1 Resistance Temperature Detectors (RTD)

Each RTD shall be platinum with a tolerance of plus or minus 0.1 percent at 32 degrees 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.

2.8.2.2 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.

2.8.2.3 RTD Transmitter

The RTD transmitter shall match the resistance range of the RTD. The transmitter shall be a 2-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated measurement.

2.8.3 Relative Humidity Instruments

Relative humidity sensing element shall have a relative humidity sensing range from 0-100 percent (condensing). The sensor shall be capable of, sensing a condensing air stream (100 percent RH) without affect to the sensors calibration or harm to the sensor. The sensor shall be wall mount type or duct mount type as appropriate and shall be provided with the required accessories. Duct sensors shall be provided with duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Sensing elements shall have an accuracy of plus or minus 5 percent of full scale within the range of 20 to 80 percent relative humidity. A 2-wire, loop powered transmitter located at the sensing element shall be provided to convert the sensing element output to a linear 4-to-20 mAdc output corresponding to the required humidity measurement. The output error shall not exceed 0.1 percent of calibrated measurement.

2.8.4 Electronic Airflow Measurement Stations and Transmitters

2.8.4.1 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 RTD or thermistor type, with linearizing means. The sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments of ASHRAE-03 and SMACNA-07 for the traversing of ducted air flows. 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 3 percent over a range of 125 to 2,500 fpm scaled to air volume.

2.8.4.2 Transmitters

Each transmitter shall produce a linear, temperature compensated 4-to-20 mAdc, output corresponding to the required velocity pressure measurement. The transmitter shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the calibrated measurement.

2.8.5 Pitot Tube Airflow Measurement Stations and Transmitters

2.8.5.1 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 set forth for measurements and instruments of ASHRAE-03 or SMACNA-07 for the traversing of ducted airflows. The resistance to airflow 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 3 percent over a range of 500 to 2,500 fpm scaled to air volume. This device shall not be used if the required velocity measurement is below 700 fpm.

2.8.5.2 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 2-wire, loop powered device. Sensing element accuracy shall be plus or minus 1 percent of full scale, and overall transmitter accuracy shall be plus or minus 0.25 percent of the calibrated measurement.

2.8.6 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 2 percent of full scale. The transmitter shall be a 2-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mAdc output

corresponding to the required pressure measurement.

2.8.7 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.

2.8.8 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.

2.9 THERMOSTATS

2.9.1 General

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 electric or low-voltage electronic.

2.9.2 Microprocessor Based Room Thermostats

Microprocessor based thermostats shall have built-in keypads for scheduling of day and night temperature settings. Access to the scheduling mode shall be by a password control code. 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 setting and interrogating time program ON-OFF setpoints for all 7 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 1 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.

2.9.3 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).

2.9.4 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.

2.9.5 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.

2.10 PRESSURE SWITCHES AND SOLENOID VALVES

2.10.1 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.

2.10.2 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. Range shall be 5.0 to 6.0 inches water gauge. 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.

2.10.3 Pneumatic Electric (PE) Switches

Each switch shall have an adjustable setpoint range of 3 to 20 psig, and differential adjustable from 2 to 6 psi.

2.11 INDICATING DEVICES

2.11.1 Insertion Thermometers

Thermometers for insertion in ductwork and piping systems 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, and shall conform to ASME PTC 19.3.

2.11.2 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.

2.11.3 Air Duct Thermometers

Air duct thermometers shall have perforated stem guards and 45 degree adjustable duct flanges with locking mechanism.

2.11.4 Averaging Thermometers

Averaging thermometers shall have 3-1/2 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270 degree arc.

2.11.5 Accuracy

Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Thermometers shall have the following ranges:

a. Mixed air, return air, cooling-coil discharge, chilled water, condenser water, and glycol cooling temperatures: 0 to 100 degrees F in 1 degree graduations.

b. Heating-coil discharge temperature: 30 to 180 degrees F in 2 degree graduations.

c. Hydronic heating systems below 220 degrees F: 40 to 240 degrees F in 2 degree graduations.

d. Glycol heating service temperature: 40 to 240 degrees F in 2 degree F degree graduations.

e. High-temperature hot water: 100 to 550 degrees F in 5 degree graduations.

2.11.6 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 3 percent of scale range. Gauges shall meet requirements of ASME B40.1.

2.11.6.1 Air Storage Tank and Filter and Dryer Gauge

Gauges for air storage tanks, and gauge for use before and after dirt and oil filters or dryers, shall have a scale of 0 to 160 psig with 2 psi graduations.

2.11.6.2 Hydronic System Gauges

Gauges for hydronic system applications shall have ranges and graduations as shown.

2.11.6.3 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 2 percent of scale range.

2.12 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 2 PDT with 8-pin connectors, dust cover, and a matching rail mounted socket. Adjustable timing range shall be 0 to 3 minutes. Power consumption shall not be greater than 3 watts.

2.13 CURRENT TO PNEUMATIC (IP) TRANSDUCERS

The transducers shall be 2-wire current-to-pressure transmitters that convert a 4-to-20 mAdc input signal to a 3 to 15 psig or a 15 to 3 psig, field reversible pneumatic output, with a conversion accuracy of plus or minus 2 percent of full scale, including linearity and hysteresis. Input impedance shall not exceed 250 ohms. Air consumption shall not be greater than 0.25 scfm.

2.14 WATTHOUR METERS

Watthour meters shall be in accordance with ANSI C12.1 and shall have pulse initiators for remote monitoring of watthour consumption. Pulse initiators shall consist of contacts (one normally open, one normally closed) with a current rating not to exceed 2 amperes and voltage not to exceed 500 V, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations. Pulse initiator contacts shall be connected to a terminal strip external to the meter enclosure. Meter sockets shall be in accordance with ANSI C12.1.

2.15 WATTHOUR TRANSDUCERS

Watthour transducers shall have an accuracy of plus or minus 0.25 percent of full scale for kW and kWh outputs from full lag to full lead power factor. Input ranges for kW and kWh transducers shall be selectable without requiring the changing of current or potential transformers. The output shall be 4-to-20 mAdc.

2.16 FIELD HARDWARE

2.16.1 Direct Digital Control (DDC) Panel Hardware

DDC panels shall be microcomputer based with sufficient memory to perform specified DDC panel functions and operations. The panel shall not be dependent on logic or data from an external computer. The panel shall contain necessary I/O functions to connect to field sensors and control devices. The DDC panel shall include:

a. Main power switch.

b. Power on indicator.

c. Portable tester connector.

d. On-Off-Auto switches for each digital output. The status of these switches will be available to the DDC panel for further processing.

e. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual potentiometer, for each analog output. The status of these switches will be available to the DDC panel for further processing.

2.16.1.1 Sealed Battery Backup

A sealed battery backup for the DDC panel memory and real time clock function sufficient to maintain them for a minimum period of 8 hours shall be provided. Automatic charging of batteries shall be provided, or alternately, lithium batteries sized to provide a minimum of 30 days operation and a shelf life of 2 years shall be provided. A low battery alarm with indication for each DDC panel shall be provided. Alternatively, capacitors may be provided to maintain memory and clock function for a

minimum of 8 hours.

2.16.1.2 Electrical Service Outlet for use with Test Equipment

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 6 feet of the DDC panel enclosure.

2.16.1.3 Locking Type Mounting Cabinets

Locking type mounting cabinets, with common keying and door switch wired to and DDC panel input for intrusion alarm annunciation, shall be furnished.

2.16.1.4 Failure Mode

Upon failure of the DDC panel, all connected points shall be forced to the failure mode shown in the I/O summary tables.

2.16.1.5 Portable Tester

Provisions for connection of a portable tester shall be furnished at each DDC panel location.

2.16.1.6 I/O Functions

I/O functions shall be provided as part of the DDC panel 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 8 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. An individual gradual switch for manual override of each analog output and means of physically securing access to these switches shall be provided. Each AO shall have a three-position switch for selection of the DDC control signal, no control, or a locally generated control signal for connection to the controlled device. Feedback shall be provided to the system as to the status of the output (manual control or automatic). Switches for pneumatic control outputs shall provide a connection for an externally generated pneumatic signal. All switches shall be either of a key operated design with the same keying system used for other outputs or otherwise suitably protected from unauthorized access.

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 1 ampere at 24 Vac. Key locked HOA switches shall be provided for manual override of each digital output. Feedback shall be provided to the system as to the status of the output (manual control or automatic). All switches shall be common keyed.

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 panel. 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.

2.16.2 Variable Air Volume (VAV) Terminal Unit Controls

The VAV terminal units shall be as specified in Section 15895 AIR SUPPPLY, DISTRIBUTION, VENTILATION AND EXHAUST SYSTEM. Terminal unit controls shall consist of individual box controllers which shall be fully interfaced to the control system through dedicated DDC panels. VAV terminal box controllers shall be interfaced to the system through the DDC panel that controls the AHU serving that box.

2.16.2.1 Box Control Device

Controls for pressure independent boxes shall consist of a velocity-sensing device in the primary air entering the box, a room temperature sensing element, a damper actuator, and an adjustable microprocessor-based VAV box controller. Each controller shall operate a damper for cooling and a duct coil for heating. Actuator shall open or close the device to which it is applied within 6 minutes. Terminal unit controls shall meet the requirements of UL 916 and 47 CFR 15.

Controls for pressure independent boxes with recirculating fans shall consist of a velocity-sensing device in the primary air entering the box, a room temperature sensing element, an adjustable microprocessor-based VAV box controller, a damper with actuator, and a duct pressure switch to operate the recirculation fan. Each controller shall operate the damper for cooling and the recirculation fan and duct coil for heating.

Each VAV box controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the VAV box controller shall automatically select either an economy or a comfort mode.

VAV box controllers shall provide an auxiliary binary output to serve as the interface to an associated lighting relay. Based upon the status of either an occupancy sensing device or a manual wall switch, the VAV box

controller shall provide a contact output to automatically turn on or off lights. Power and associated transformers, as needed, shall be provided from the nearest lighting circuit to the VAV box controller.

2.16.2.2 Communication and Programming Device

One hand-held communication and programming device with instruction manual, plus 1 additional hand-held communicating device and instruction manual per 100 terminal units, shall be provided. The communication and programming device shall connect to the controller directly. The communication and programming device shall be used to read and set minimum velocity, maximum velocity, heating setpoint, and cooling setpoint, and to read velocity and space temperature.

2.16.3 Command Entry Device

A command entry device shall be provided for use with DDC panels. All equipment must be Year 2000 compliant. The command entry device shall include a keyboard and display for local programming and setup. A printer and disk system shall also be provided. The command entry device shall be provided with communications interfaces to each DDC panel, and shall:

a. Allow for entry of database information, including parameters and constraints from the keyboard.

b. Display any digital, analog, and pulse accumulator input.

c. Control any digital and analog output.

d. Provide operator interface in alphanumeric and decimal.

e. Disable/enable any DDC panel.

2.16.3.1 Communications

A port and proper cabling shall be provided to allow for communications between the command entry device and the DDC panel.

2.16.3.2 Keyboard

A keyboard shall be furnished with the command entry device panel. The keyboard shall include a 64-character standard ASCII character set based on ANSI X3.64 and ANSI X3.154. The keyboard shall also include a 10-key numeric keypad and 10 programmable function keys, light pen, or mouse. The keyboard shall provide a means for the operator to interact with all command and applications software.

2.16.3.3 Printer

A printer shall be provided for use with the command entry device panel. The printer shall have a minimum 96 character standard ASCII character set. It shall have adjustable sprockets for paper width up to 9.5 inches and a friction feed for paper width up to 8.5 inches, and shall print at least 80 columns per line. The printer shall have a minimum speed of 150 characters per second in utility mode (draft quality) and 32 characters per second in near-letter quality mode. Print mode shall be switch or software selectable. The minimum character spacing shall be 10 characters per inch and 3 to 8 lines per inch. The printer shall utilize standard form size, sprocket-fed fanfold paper. The unit shall have programmable control of

top-of-form and variable line skip capability.

2.16.3.4 Hard Disk

The command entry device shall include a hard disk system having a maximum average access time no greater than 19 milliseconds, and a minimum of 65 megabytes of formatted storage. The device shall allow each DDC panel database to be stored as a separate file suitable for transfer to floppy disk.

2.16.3.5 Floppy Disk

The command entry device shall include a 5-1/4 inch high density or a 3.5 inch high density floppy disk system as part of the command entry device providing a minimum of 1.2 megabytes of formatted storage.

2.16.4 DDC Panel Portable Tester

Either as part of the command entry device or as a separate portable device capable of connection to any DDC panel, a portable test device shall be provided which includes a keyboard, display, and mass storage sufficient to perform, as a minimum, the following functions through the portable tester:

a. Load all DDC panel software and information, including parameters and constraints.

b. Display the status or value of all points connected to the DDC panel.

c. Control the outputs connected to the DDC panel.

d. Perform DDC panel diagnostic testing.

e. Provide operator interface in alphanumerics and decimal (hexadecimal, octal, and binary display shall not be utilized).

f. Accept DDC panel software and information from the command entry device panel for subsequent loading into a specific DDC panel. Provide all necessary software and hardware required to support this function.

2.16.5 DDC Panel Test Set

A DDC panel test set, consisting of a DDC panel and I/O simulator, shall be provided for use, located as shown, connected via a separate data transmission media (DTM) circuit. The I/O simulator shall manually generate the values or status for all I/O functions specified. The I/O simulator shall receive, display, and send different types of signals. Cables, connectors, test jacks, controls, indicators, and equipment required to simulate the I/O sensors and control devices and display the operation of all types of DDC panels used by the system shall be included. Indicators and controls shall be installed in a control panel. Test jacks for input and output signal of the I/O simulator shall be front panel mounted for use in diagnostics and evaluation. The I/O functions mix, including indicators and controls, shall be at least:

a. 4 AI.

b. 4 AO.

c. 16 DI.

d. 16 DO.

e. 2 pulse accumulator inputs.

f. One each of any other type utilized in the system.

2.16.6 Communication Equipment

The DDC panel shall be equipped with hardware to allow for communication to the Data Terminal Cabinet and Base EMCS system.

2.16.7 Dial Up Modem

A type V.32 Modem operating at 1,200 or 2,400 BPS with automatic/selectable fall back operation with automatic answer and automatic dial capability shall be connected to the control system and to the telephone system and shall be certified to meet the requirements of 47 CFR 68.

2.17 DIRECT DIGITAL CONTROL PANEL SOFTWARE

Each DDC panel, shall contain an operating system that controls and schedules that DDC panel's activities in real time. The DDC panel shall maintain a point database in its RAM that includes all parameters, constraints, and the latest value or status of all points connected to that DDC panel. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. The operating system shall allow local loading of software and data files from the portable tester and from an operator interface panel.

2.17.1 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, ensuring that the correct command will be issued when the time constraint is no longer in effect or report the rejected command. Override command entered by the operator shall have higher priority than those emanating from application programs.

2.17.2 DDC Panel Startup

The DDC panel shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A DDC panel restart program based on detection of power failure at the DDC panel shall be included in the DDC panel software. Upon restoration of power to the DDC panel, the program shall restart all equipment and restore all 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 panel and if the database and application software are no longer resident, or if the clock cannot be read, the DDC panel shall not restart and systems shall remain in the

failure mode until the necessary repairs are made. If the database and application programs are resident, the DDC panel shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each DDC panel shall include a unique time delay setting when system operation is initiated.

2.17.3 DDC Panel Operating Mode

Each DDC panel shall control and monitor all functions independent of communication with any other source. The software shall perform DDC panel functions and DDC panel resident application programs using data obtained from I/O functions and based upon the DDC panel real time clock function. The DDC panel software shall execute commands after performing constraint checks in the DDC panel.

2.17.4 DDC Panel Failure Mode

Upon failure for any reason, the system shall perform an orderly shutdown and force all DDC panel outputs to a predetermined state, consistent with the failure modes defined in the I/O summary tables and the associated controlled devices.

2.17.5 DDC Panel Functions

Software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within the DDC panel shall be provided:

a. Scanning of inputs.

b. Control of outputs.

c. Store alarms for reporting when requested.

d. Maintain real time.

e. Execute DDC panel resident application programs.

f. Averaging or filtering of each analog input.

g. Constraint checks, prior to command issuance.

h. DDC panel diagnostics.

i. DDC panel portable tester operation.

2.17.6 Analog Monitoring

The DDC panel shall measure analog values and shall be capable of transmitting analog values for display. An analog change in value is defined as a change exceeding a preset differential value as specified. Displays and reports shall express analog values in proper engineering units with polarity sign. The system shall accommodate up to 255 different sets of engineering unit conversions. Each engineering unit conversion shall include range, span, and conversion equation.

2.17.7 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.

This value shall be created by calculating it from any combination of digital and analog points, or other data. Logic points shall be analog or digital points having all the properties of real points, including alarms, without the associated hardware. Logic points shall be defined or calculated and entered into the database by the Contractor as required. 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. Calculated point values shall be current for use by the system within 30 seconds of the time any input value changes and shall include:

a. Control loop setpoints.

b. Control loop gain constants.

c. Control loop integral constants.

d. Summer/winter operation.

e. Real time.

f. Scheduled on/off times.

g. Equipment run-time targets.

h. Calculated point values.

2.17.8 I/O Point Definition

Each I/O point shall be defined in a database in the DDC panel. The definition shall include all physical parameters and constraints associated with each point.

2.17.9 Parameter Definition

Each I/O 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, motors).

c. Point identifications number.

d. Area.

e. Sensor range.

f. Controller range.

g. Sensor span.

h. Controller span.

i. Engineering units conversion (scale factor).

j. High and low reasonableness value (analog).

k. High and low alarm limit (analog).

l. High and low alarm limit differential (return to normal).

m. Analog change differential (for reporting).

n. High accumulator limit (pulse).

o. Status description (digital inputs).

2.17.10 Alarm Processing

Each DDC panel shall have alarm processing software for digital, analog, and pulse accumulator alarms for all input and virtual points connected to that DDC panel.

2.17.10.1 Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by digital inputs as specified in the I/O Summary Tables and elsewhere.

2.17.10.2 Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an analog input as specified in the I/O Summary Tables and elsewhere. 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 panel database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return to the proper operating range before being declared as a return-to-normal state. Limits and differentials shall be entered on line by the operator in limits or the measured variable, without interruption or loss of monitoring of the point concerned.

2.17.10.3 Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or pulse accumulator inputs rates that are outside defined limits as specified in the I/O Summary Tables and elsewhere. Pulse accumulator 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 pulse accumulator point in the system. Limits shall be stored in the DDC panel database.

2.17.10.4 Equipment Constraints Definitions

Each control point in the database shall have DDC panel resident constraints defined and entered by the Contractor, including as applicable:

a. Minimum off time.

b. Minimum on time.

c. High limit (value in engineering units).

d. Low limit (value in engineering units).

2.17.10.5 Constraint Checks

Control devices connected to the system shall have the DDC panel memory resident constraints checked before each command is issued to ensure that no equipment damage will result from improper operation. Each command shall be executed by the DDC panel only after all constraint 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 analog input. Values outside the reasonableness limits shall be rejected and an alarm generated. Status changes and analog point values shall be reported upon request, such as for reports, and application programs. Each individual point shall be capable of being selectively disabled by the operator. Disabling a point shall prohibit monitoring and automatic control of that point.

2.17.11 DDC Panel Diagnostics

Each DDC panel shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be provided for use in the portable tester. The software shall display messages in plain language to inform the tester's operator of diagnosed problems.

2.17.12 Summer/Winter Operation Monitoring

The system shall provide software to change the operating parameters, monitoring of alarm limits, and start-stop schedules for each mechanical system where such a change from summer to winter and vice versa is meaningful. The software shall provide commands to application programs to coordinate summer or winter operation.

2.17.13 Control Sequences and Control Loops

Operator commands shall be used to create and execute control sequences and control loops for automated control of equipment based on operational parameters including times and events, defined in the database. Through the command entry device, the system shall prompt the operator for information necessary to create, modify, list, and delete control sequences and Proportional-plus-Integral-plus Derivative (PID) control loops. The system shall prompt the operator for confirmation that the control sequence and control loop addition/modification/deletion is correct, prior to placing it in operation. Mathematic functions required shall be available for use in creating the control sequences and control loops. Sufficient spare memory shall be provided to allow four control sequences and four control loops in addition to those necessary to implement the requirements specified for each DDC panel. Each control sequence shall accommodate up to eight terms or devices.

2.17.14 Communication Programs

The DDC panels shall be equipped with software drivers and handlers which allow for communication with a base-wide EMCS/UMCS. The software drivers shall allow for communications via modems, line drivers, transmitters/receivers over LAN, wirelines, fiber optic or coaxial cables. The software shall be structured to support communication over a network with star, ring, radial, or a combination of topologies. Each communication program module shall be functionally independent of other Contractor-furnished software, to allow for future upgrade or replacement of communication modules without affecting other application programs and other software modules. Communication protocol for communication shall

conform to a standard communication protocol.

2.18 WIRE AND CABLE

2.18.1 Digital Functions

Control wiring for digital functions shall be 18 AWG minimum with 600-volt insulation. Multiconductor wire shall have an outer jacket of polyvinyl chloride (PVC).

2.18.2 Analog Functions

Control wiring for analog functions shall be 18 AWG minimum with 600-volt insulation, twisted and shielded, 2-, 3-, or 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.18.3 Sensor Wiring

Sensor wiring shall be 20 AWG minimum twisted and shielded, two-, three-, or four-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.18.4 Class 2 Low Energy Conductors

The conductor sizes specified for digital and analog functions shall take precedence over any requirements for Class 2 low energy remote-controlled and signal-circuit conductors specified elsewhere.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

Contractors are required to participate in the pre-commissioning checks and functional performance testing during the commissioning process specified in 15995.

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 all software on each type of media utilized, within 30 days of formal Government acceptance. In addition, a copy of individual floppy disks of

all 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 all 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. 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. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other 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 Local Gauges for Actuators

Pneumatic actuators shall have an accessible and visible receiver gauge installed in the tubing lines at the actuator as shown.

3.2.3 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 5 feet above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

3.2.4 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.

3.2.5 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.

3.2.6 Foundations and Housekeeping Pads

Foundations and housekeeping pads shall be provided for the HVAC control system air compressors.

3.2.7 Duct Static-Pressure Sensing Elements and Transmitters

The duct static-pressure sensing element and transmitter sensing point shall be located approximately two-thirds of the distance from the supply fan to the end of the duct with the greatest pressure drop.

3.2.8 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

3.2.9 Tubing

3.2.9.1 Control System Installation

All tubes and tube bundles exposed to view shall be installed neatly in lines parallel to the lines of the building. Tubing between panels and actuators in mechanical/electrical spaces shall be routed so that the lines are easily traceable.

3.2.9.2 Connection to Liquid and Steam Lines

Tubing for connection of sensing elements and transmitters to liquid and steam lines shall be copper with brass compression fittings.

3.2.9.3 Connection to Ductwork

Tubing for connection of sensing elements and transmitters to ductwork shall be plastic tubing.

3.2.9.4 Tubing in Concrete

Tubing in concrete shall be installed in rigid conduit. Tubing in walls containing insulation, fill, or other packing materials shall be installed in raceways dedicated to tubing.

3.2.9.5 Final Connection to Actuators

Final connections to actuators shall be plastic tubing 12 inches long and unsupported at the actuator.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 General Requirements - HVAC System

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.1.1 Supply Fan Operating

HVAC system outside air, return air, and relief air dampers shall function as described for specific modes of operation unless control of the dampers is assumed by the fire and smoke control system. Smoke dampers shall open before fans are allowed to start. Interlocked exhaust fans shall be stopped in the unoccupied and ventilation-delay modes and their dampers shall be closed. Interlocked exhaust fans shall run in the occupied mode, and their dampers shall open. Cooling-coil control valves and cooling-coil circulating pumps shall function as described for the specific modes of operation unless their control is assumed by the freeze-protection system. Heating coil valves shall be under control.

3.3.1.2 Supply Fan Not Operating

When an HVAC system is stopped, all interlocked fans shall stop, the smoke dampers shall close, the outside air and relief air dampers shall close, the return air damper shall open, all stages of direct-expansion cooling shall stop, the system shall pump down if it has a pump down cycle, all humidification shall stop, and all cooling-coil valves for coils located indoors shall close to the coil. Cooling-coil valves of units located outdoors shall open to the coil. Heating-coil valves shall remain under control.

3.3.1.3 Hydronic Heating - Distribution Pump Operating

Hydronic heat-exchanger valves shall be under control.

3.3.1.4 Hydronic Heating - Distribution Pump Not Operating

Hydronic heat-exchanger valves shall close.

3.3.2 Reheat Hot Water ATU Unit

All Modes - A wall-mounted thermostat, located as shown, shall cycle the fan to maintain the setpoint as shown. When the hot water valve is on, a 2-way valve shall open to the coil. When the hot water valve is off, the 2-way valve shall bypass the coil.

3.3.3 Single Building Dual-Temperature Hydronic

Heating and cooling modes shall be manually selected.

3.3.3.1 Heating Mode

When the heating mode is selected, chiller CH-1 shall be stopped. Distribution pump HWP-1 shall continue to operate until the expiration of a time delay as recommended by the chiller manufacturer. At the expiration of the time delay, the system changeover valves shall close to flow through the chiller and shall open to flow through the boiler, and distribution pump HWP-1 shall be under control of the DDC system. The DDC system shall accept a signal from a sunshielded outside air temperature sensing element and transmitter located as shown. The DDC system shall start and stop the distribution pump HWP-1, the boiler pump, and the boiler B-1 at the outside air temperatures shown. The DDC system shall reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside air temperature as shown. The DDC system shall accept a signal from a temperature sensing element and transmitter located in the hydronic supply line and the DDC system output shall modulate the hydronic-heating system control valve to maintain the reset schedule setpoint in the

hydronic-heating supply line.

3.3.3.2 Cooling Mode

When the cooling mode is selected, the boiler B-1 and the boiler pump shall be stopped. The DDC system shall accept a signal from a temperature sensing element and transmitter located in the system supply as shown. The DDC system shall continue to operate the distribution pump CHWP-1 to circulate water through the system with the boiler shut off. When the system supply-water temperature drops below the setpoint shown, the DDC system shall allow the changeover valves to close to flow through the boiler and to open to flow through the chiller, and shall place the chiller and the distribution pump CHWP-1 under control of the system time schedule. During the occupied mode, the distribution pump CHWP-1 shall operate continuously and chiller CH-1 shall be permitted to operate. When the control system is in the unoccupied mode, chiller CH-1 shall shut down. Distribution pump CHWP-1 continue to operate until the expiration of the time delay.

3.3.4 Variable Air Volume Control Sequence with Return Fan

3.3.4.1 Occupied, Unoccupied, and Ventilation-Delay Modes of Operation

Ventilation-delay mode timing shall start prior to the occupied-mode timing. The DDC system shall prevent the outside air damper from opening. At the time shown, the DDC system shall place the system in the occupied mode. At the expiration of the ventilation-delay mode timing period, the DDC system shall allow the outside air damper to open. At the time shown, the DDC system shall place the control system in the unoccupied mode of operation.

3.3.4.2 Outside Air, Return Air, and Relief Air Dampers

Occupied Mode - The outside air, return air, and relief air dampers shall be under mixed air temperature and economizer control.

Unoccupied Mode - The dampers shall return to their normal positions as shown.

Ventilation-Delay Mode - The dampers shall return to their normal positions as shown, except when under economizer control.

3.3.4.3 Supply Fan and Return Fan Control

Occupied and Ventilation-Delay Modes - Supply fan AH-1 and AH-2 and return fan RF-1 and RF-2 shall start, and shall operate continuously.

Unoccupied Mode - The supply fan and the return fan shall cycle according to the night setback schedule. The fans shall start and stop at the setpoints as shown.

3.3.4.4 Supply-Duct Pressurization Control

When the supply fan starts, the DDC system shall modulate the inlet vanes from the signal of a static pressure-sensing element and transmitter to maintain the setpoint as shown. A high-limit static-pressure switch in the fan discharge shall stop the supply fan and the return fan and initiate a high-static alarm when the static pressure exceeds the setpoint. When the

fan is off, the inlet vane shall be closed.

3.3.4.5 Return-Fan Volume Control

When the return fan starts, the DDC system shall modulate the return fan vanes from the signals of an air-flow measurement station and transmitter the return-fan inlet ductwork, in combination with an air-flow station and transmitter in the supply-fan outlet ductwork, to maintain constant difference between supply-air and return air flow rates as shown.

3.3.4.6 Filter

A differential pressure switch across the filter shall initiate a filter alarm when the pressure drop across the filter reaches the setpoint as shown.

3.3.4.7 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply and return fans, cause the outside air, return air, and relief air dampers to return to their normal position, and shall initiate a low-temperature alarm if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset at the freezestat. The DDC panel shall monitor the freezestat through auxiliary contacts and shall indicate an alarm condition when the freezestat trips.

3.3.4.8 Cooling Coil

Occupied and Ventilation-Delay Modes - The control valve shall be modulated by the DDC system from the signal of a temperature-sensing element and transmitter located in the coil discharge air to maintain the setpoint as shown.

Unoccupied Mode - The DDC system shall close the cooling-coil control valve.

3.3.4.9 Humidity Control

Occupied Mode - The DDC system shall accept the signals from a space relative humidity sensor and a duct relative humidity sensor to control the humidifier valve and the cooling coil valve. The DDC system shall gradually open the cooling-coil valve in the event that the space relative humidity continues to rise after the humidifier valve is closed. The DDC system shall gradually operate the humidifier valve from the signal of a space relative humidity sensor/transmitter to maintain relative humidity setpoint. The DDC system shall receive a signal from a relative humidity sensor/transmitter in the ductwork downstream of the humidifier and shall limit the relative humidity at that point to a high-limit relative humidity setpoint.

Unoccupied and Ventilation-Delay Modes - The humidifier valve shall be closed.

3.3.4.10 Economizer Control

The DDC system shall accept the signal of an outside air temperature sensing element and transmitter and the signal of a return air temperature sensing element and transmitter. The DDC system shall perform switchover between outside air economizer control mode and minimum outside air mode. Until the return air temperature rises above the setpoint, the DDC system

shall hold the system in the minimum outside air mode. When the return air temperature rises above the setpoint, the DDC system shall place the AHU in the economizer mode or in the minimum outside air mode, as determined by a comparison of the outside air and return air temperatures in accordance with the differential temperature setpoints. When the outside air temperature is low with respect to the return air temperature, the AHU shall be in the economizer mode. When the DDC system places the control system in the minimum outside air mode, the outside air damper shall be open to the minimum outdoor air setting.

3.3.4.11 Mixed-Air Temperature Control

When the DDC system places the control system in the economizer mode, it shall modulate the dampers from the signal of a temperature sensing element and transmitter in the mixed-air stream to maintain the setpoint as shown.

3.3.4.12 Pressure-Independent Terminal VAV Box with Velocity Controller

All Modes - The control damper of the VAV box shall modulate in response to the signal from a flow sensing element at the discharge or inlet of the VAV box to a microprocessor-based VAV-box velocity controller. The velocity controller shall control the box damper from the minimum-flow position to the full-flow position from the signal of a space temperature sensing element located as shown. When the space temperature decreases, the damper shall gradually close to the minimum flow position to maintain the cooling setpoint. When the space temperature calls for heating after the minimum flow position is reached, control shall then pass through a temperature dead band. When the space temperature has dropped through the dead band, the duct heater coil shall be gradually controlled to maintain the heating setpoint.

3.3.4.13 Smoke Control

All Modes - Smoke detectors in the supply-air and return air ductwork shall stop the supply fan and the return fan and initiate a smoke alarm if smoke is detected at either location. Restarting the supply fan and the return fan shall require manual reset of the smoke detector at the fire alarm control panel.

3.4 COMMISSIONING PROCEDURES

3.4.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, set the time schedule, and make any necessary control-system corrections to ensure that the systems function as described in the sequence of operation.

3.4.1.1 Item Check

Signal levels shall be recorded for the extreme positions of each controlled device. An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shut down; Step 4 shall be performed after the HVAC systems have been started. External input signals to the DDC panel (such as starter auxiliary contacts, and external systems) may be simulated in steps 1, 2, and 3. With each operational-mode signal change, DDC panel output relay contacts shall be observed to ensure that they

function.

3.4.1.2 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.

3.4.1.3 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the DDC panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-DDC panel readout accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-DDC panel readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

3.4.1.4 Insertion and Immersion Temperatures

Insertion temperature and immersion temperature sensing elements and transmitter-to-DDC panel readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

3.4.1.5 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-DDC panel readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

3.4.2 Space Temperature Controlled Perimeter Radiation

The heating medium shall be turned on, and the thermostat temperature setpoint shall be raised. The valve shall open. The thermostat temperature shall be lowered and the valve shall close. The thermostat shall be set at the setpoint shown.

3.4.3 Single Building Dual Temperature Hydronic

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power and main air are available where required.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each temperature shall be read at the DDC panel, and the thermometer and DDC panel readings logged. The calibration accuracy of the sensing element-to-DDC

panel readout for outside air temperature, system-supply temperature, and system return temperature shall be checked.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, through an operator entered value. The proper operation of the actuators and positioners for all valves shall be visually verified. The signal shall be varied from live zero to full range, and actuator travel from zero stroke to full stroke within the signal range shall be verified. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) The two-point calibration sensing element-to-DDC panel readout accuracy check for the outside air temperature shall be performed. Any necessary software adjustments shall be made to setpoints or parameters to achieve the outside air temperature schedule.

(2) The system shall be indexed to the heating mode and it shall be verified that chiller CH-1 is shut down and that pump HWP-1 continues to operate until the time delay expires. It shall be verified that the changeover valves open to flow through boiler B-1 and close to flow through chiller CH-1.

(3) The outside air temperature shall be simulated through an operator entered value to be above the setpoint. It shall be verified that pump HWP-1 stops. A value shall be entered to simulate that the outside air temperature is below the setpoint. It shall be verified that pump HWP-1 starts.

(4) The two-point calibration accuracy check of the sensing element-to-DDC panel readout for the system-supply temperature shall be performed. The system supply temperature setpoint shall be set for the temperature schedule as shown. Signals of 8 ma and 16 ma shall be sent to the DDC panel from the outside air temperature sensor, to verify that the system supply temperature setpoint changes to the appropriate values.

(5) The two-point accuracy check of sensing element-to-DDC panel readout for the system-return temperature shall be performed. It shall be verified that the return-water temperature setpoint is set to the setpoint. The system shall be placed in the occupied mode.

(6) The system shall be indexed to the cooling mode. It shall be verified that boiler B-1 shuts down, that pump CHWP-1 continues to operate until the return water temperature falls below its setpoint, that the changeover valves close to flow through the boiler B-1 and open to flow through chiller CHWP-1, and the chiller operates.

(7) The system shall be placed in the unoccupied mode and it shall be verified that chiller CH-1 shuts down and pump CHWP-1 continues to operate until the expiration of the time delay and then stops.

3.4.4 Variable Air Volume Control System with Return Fan

Steps for installation shall be as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power and main air are available where required, and that the outside air and relief air dampers are closed, the return air damper is open and return/relief fan inlet vanes, the supply fan inlet vanes, and cooling coil valve are closed.

b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each temperature shall be read at the DDC panel, and the thermometer and DDC panel display readings logged. The calibration accuracy of the sensing element-to-DDC panel readout for outside air, return air, mixed-air, and cooling-coil discharge-air temperatures shall be checked. The supply air flow and return air flow shall be read, using a digital indicating velometer, and the velometer and DDC panel display readings logged. The flows should read zero.

c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator through an operator entered value at the DDC panel. The proper operation of the actuators and positioners for all dampers and valves shall be visually verified. The signal shall be varied from live zero to full range, and actuator travel shall be verified from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

d. Step 4 - Control-System Commissioning:

(1) With the fans ready to start, the system shall be placed in the ventilation-delay mode and in the occupied mode, and it shall be verified that supply fan AH-1 and AH-2 and return fan RF-1 and RF-2 start. It shall be verified that the outside air damper and relief air damper are closed, the return air damper is open, and the cooling coil valve and inlet vanes are under control, by simulating a change in the fan discharge temperature. The system shall be placed out of the ventilation-delay mode, and it shall be verified that the outside air, return air and relief air dampers come under control by simulating a change in the mixed air temperature.

(2) The system shall be placed in the minimum outside air mode and it shall be verified that the outside air damper opens to its minimum position.

(3) The starter switch of return fan RF-1 and RF-2 shall be turned to the OFF position, and the inlet vane damper shall be opened. With supply fan AH-1 and AH-2 running, a high-static-pressure input signal shall be simulated at the device by pressure input to the sensing device. HVAC system shutdown shall be observed, it shall be verified that the high-static alarm is initiated. The HVAC system shall be restarted by manual reset, and it shall be verified that the high-static alarm returns to

normal.

(4) The two-point accuracy check of sensing element-to-DDC panel readout for the static pressure in the supply duct shall be performed.

(5) Each VAV terminal unit controller's minimum flow and maximum flow setpoints shall be set at the same setting. This will prevent the VAV-box damper from modulating under space temperature control and will achieve a constant supply-duct system pressure drop. The return-fan inlet vane shall be placed under control, and the starter switch shall be turned to the "AUTO" position so that the fan starts. The two-point calibration accuracy check of sensing element-to-DDC panel readout for the 2-air flow measurement stations shall be performed. The supply-fan inlet vane shall be operated manually to change the supply-fan flow, and the control system shall be set to control at 0 L/S cfm at 4-ma input and 17675 for AH-1 and 8764 L/S for AH-2 cfm at 20-ma input. The supply fan flow shall be changed to verify that the return-flow setpoint tracks the supply-fan flow with the proper flow difference.

(6) The two-point calibration accuracy check of sensing element-to-DDC panel readout for outside air, return air, and mixed-air temperatures shall be performed. Temperature setpoint shall be set as shown.

(7) The two-point calibration accuracy check of sensing element-to-DDC panel readout for the fan discharge temperature shall be performed. The setpoint for the fan discharge temperature shall be set as shown. A change shall be simulated in the discharge air temperature through an operator entered value and it shall be verified that the control valve is modulated.

(8) The system shall be placed in the unoccupied mode and it shall be verified that the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The space temperature shall be artificially changed to below the night setback temperature setpoint, and it shall be verified that the HVAC system starts; the space temperature shall be artificially changed to above the night setback temperature setpoint and it shall be verified that the HVAC system stops. The night setback temperature setpoint shall be set at the setpoint.

(9) With the HVAC system running, a filter differential pressure switch input signal shall be simulated, at the device. It shall be verified that the filter alarm is initiated. The differential pressure switch shall be set at the setpoint as shown.

(10) With the HVAC system running, a freezestat trip input signal shall be simulated, at the device. HVAC system shutdown shall be verified. It shall be verified that a low temperature alarm is initiated. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart and it shall be verified that the alarm returns to normal.

(11) With the HVAC system running, a smoke detector trip input signal shall be simulated, at each device. Control-device actions and interlock functions as described in the Sequence of Operation

shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and the smoke detector alarm is initiated. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and the alarm return to normal shall be verified.

(12) For each VAV terminal unit, velocity setpoints shall be set for minimum and maximum flow, and temperature setpoints for the heating/cooling dead band. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

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DIVISION 15 - MECHANICAL

SECTION 15990

TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

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SECTION 15990

TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

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 S1.4	(1983; S1.4A) Sound Level Meters
ANSI S1.11	(1986; R 1993) Octave-Band and Fractional-Octave-Band Analog and Digital Filters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 111	(1988) Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems

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-01	(1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-07	(1993) HVAC Systems - Testing, Adjusting and Balancing

1.2 GENERAL REQUIREMENTS

The Contractor shall select AABC MN-1, NEBB-01, SMACNA-07 orASHRAE 111 as the standard for providing testing, adjusting and balancing of air and water systems. The selected standard shall be used throughout the project. Testing, adjusting, and balancing shall be accomplished by a firm certified for testing and balancing by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Prior to

testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Approved detail drawings and all other data required for each system and/or component to be tested shall be made available at the jobsite during the entire testing, adjusting and balancing effort. The Contractor shall verify that all balancing devices are properly installed to permit testing, adjusting and balancing and that all duct leakage tests have been completed prior to testing, adjusting and balancing. The Contracting Officer shall be notified in writing of all equipment, components, or balancing devices, that are damaged, incorrectly installed, or missing, as well as any design deficiencies that will prevent proper testing, adjusting, and balancing. Testing, adjusting, and balancing shall not commence until approved by the Contracting Officer. Instrumentation accuracy shall be in accordance with the standard selected in this paragraph. Sound level measuring equipment shall be rated in accordance with ANSI S1.4 and ANSI S1.11. The Contractor is required to take part in the commissioning process as a team member, and will be required to participate in the pre-commissioning checks and the functional performance testing specified.

1.3 INSTRUMENT ACCURACY REQUIREMENTS

All instrumentation shall be checked for accuracy before beginning testing, adjusting and balancing procedures. Instrument accuracy shall be in accordance with the standard selected in paragraph GENERAL REQUIREMENTS. Checks may be carried out against similar equipment maintained specifically for checking purposes or by the manufacturer or a recognized testing facility. All instrumentation used for testing shall be calibrated within 6 months of use. Pitot tubes and U-tube manometers do not require checking. In no case shall the instrumentation accuracy be less than specified by the instrument manufacturer. Any instrument falling out of calibration during the process of balancing and testing shall be recalibrated or removed from the site and replaced by a properly calibrated instrument. No instruments shall be allowed to remain on-site that are not in calibration.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Testing and Balancing; FIO.

Three copies of a preliminary report, 30 days before balancing commences. The report shall be organized by specific systems and shall clearly identify each item of equipment to be tested, adjusted, and balanced. The appropriate test procedures and measurements to be taken for each item of equipment shall be listed. Instrument calibration records shall be provided on forms shown in AABC MN-1 or SMACNA-07. Manufacturer's specified accuracy shall be shown. The report shall include floor plans showing all measurement locations and types of measurements to be made. All related data necessary for testing, balancing, and adjusting, including fan curves and pump curves, shall be included. A system readiness checklist, similar to that shown in SMACNA-07, shall be included. The report shall contain a listing of the deficiencies of all systems to be tested, adjusted and balanced and the corrective action taken. The report

shall contain a schedule for the testing and balancing. Six copies of the final report on forms shown in AABC MN-1 or SMACNA-07, 30 days after completion of the test and balance operation. Data shall be in a hard bound cover identifying the project name, location, date of submittal, name of Contractor, and a general title indicating the specific area and type of work, and shall be signed by a registered professional engineer, employed by the test and balance firm, who has a minimum of 2 years experience in testing, adjusting and balancing work. The final report shall include a summary describing test methods, test results, and major corrective actions taken. The report shall include as-tested floor plans showing all measurement locations and types of measurements made. The air handling unit data shall include a static pressure profile diagram, and pitot tube traverses where possible. The VAV terminal data shall include maximum and minimum air flows, for design and actual conditions, and shall be supported with summaries which show the air outlet totals for each VAV terminal and the VAV terminal totals for each air handling unit. Air distribution data shall include coded drawings which show the exact location of each air outlet. Pump data shall include pump efficiency. Data for chillers, heating and cooling coils, and heat exchangers, shall include heat balance calculations.

All instruments that are recalibrated and brought back onto the jobsite after being found to be out of calibration shall have recalibration records submitted on forms shown in AABC MN-1 or SMACNA-07.

SD-13 Certificates

Qualification; FIO.

Qualification data, 90 days prior to testing and balancing operations. The test and balance firm shall be certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). The lead balancing technician shall be qualified by AABC or NEBB and his qualification data shall include past experience on at least five similar projects.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 TESTING AND BALANCING

3.1.1 General

The facility shall be essentially complete with final ceiling, walls, windows, doors and partitions in place. Doors and windows surrounding each area to be balanced shall be closed during testing and balancing operations. Air systems shall be complete and operable with balancing dampers, ducting, diffusers, returns, flow control boxes and control components in place. Exhaust fans and fume hoods shall be operational. Hydronic systems shall be complete and operable with balancing valves, flow meters, coils, pumps, piping and control components in place. All measurements and adjustments shall be made using procedures described in standard selected in paragraph GENERAL REQUIREMENTS. Air motion and distribution from air terminals shall be as shown. Smoke tests may be used to demonstrate proper air distribution from air terminals. All data including deficiencies encountered and corrective action taken shall be recorded. If a system cannot be adjusted to meet the design requirements, the Contractor shall promptly notify the Contracting Officer in writing.

3.1.2 Air Systems

Clean filters shall be installed at the beginning of the testing, adjusting, and balancing effort. Each system shall be adjusted until all flow quantities are within plus ten percent and minus zero percent. Dampers shall be checked for tight shutoff. Air leakage around dampers shall be verified. Face and bypass dampers shall be set for air flow through coils. Fans shall be checked for correct direction of rotation and proper speed shall be verified. Fire and smoke dampers shall be tested at system design air flow to ensure proper closure in accordance with NFPA 90A and manufacturer's instructions prior to building occupancy.

3.1.2.1 General Balancing Methods

In addition to the requirements for specific systems, flows in supply, exhaust and return air systems shall be balanced using the methods in standard selected in paragraph GENERAL REQUIREMENTS. Throttling losses shall be limited. Air flow adjustments shall be made by first adjusting the fan speed to meet the design flow conditions. Fan speed adjustment may not be required for fan motors which are less than one horsepower, or if throttling results in no greater than an additional 1/3 horsepower draw above that required if the fan speed were adjusted. Flows and pressures shall be checked in all main risers and supply ducts at all supply, exhaust and return fan discharges. All flows shall be recorded before and after each adjustment.

3.1.2.2 Specific Systems

All special or additional procedures for testing and balancing shall be in accordance with the applicable requirements of the standard selected in paragraph GENERAL REQUIREMENTS. If a system has diversity, only the required quantity of wide open terminals shall be used to meet the design air flow.

3.1.3 Hydronic Systems

All valves and control components shall be open or set as required for maximum system flow. Each system shall be adjusted until all flow quantities are within the tolerances of the standard selected in paragraph GENERAL REQUIREMENTS. Pumps shall be checked for proper speed. Pump activation signal and deactivation signal valves shall be verified. Pump motor current shall be checked at maximum design flow. Variable speed pumping systems shall be tested at a minimum of four separate flow conditions to simulate design diversity.

3.1.3.1 General Balancing Methods

In addition to the requirements for specific systems, flows in piping, coils and other hydronic system components shall be balanced using the flow meter, equipment pressure drop or pump curve methods in accordance with the applicable provisions of the standard selected in paragraph GENERAL REQUIREMENTS. Flows shall be checked in all main risers and branches and condenser water lines and at all heating and cooling coils, heat exchangers, boilers, chillers, and pump discharges. Pressure taps on all pumps shall be made at factory suction and discharge tappings where available. All flows shall be recorded before and after each adjustment.

3.1.3.2 Specific Systems

Where specific systems require special or additional procedures for testing and balancing, such procedures shall be in accordance with the standard selected in paragraph GENERAL REQUIREMENTS. If a system has diversity, only the required quantity of wide-open terminals shall be used to meet the design water flow.

a. Summer-Winter: Summer-winter systems shall be balanced in the summer mode of operation. Following completion of the summer-mode balancing, equipment used for winter operation shall be balanced.

3.1.4 Marking of Setting

Following final acceptance of certified reports by the Contracting Officer, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the testing and balancing engineer so that adjustment can be restored if disturbed at any time.

3.1.5 Marking of Test Ports

The testing and balancing engineer shall permanently and legibly mark and identify the location points of the duct test ports. If the ductwork has exterior insulation, these markings shall be made on the exterior side of the ductwork insulation. All penetrations through ductwork and ductwork insulation shall be properly sealed to prevent air leakage or loss of vapor barrier.

3.1.6 Sound Level Testing

After the systems are properly tested, adjusted and balanced, sound levels shall be checked in accordance with the applicable provisions of AABC MN-1. Octave-band analysis and noise-criteria curve data shall be recorded on forms shown in AABC MN-1. All occupied areas including offices, corridors, auditorium and meeting rooms, and hospital rooms shall be verified to be within the sound levels shown or as specified. Any areas not meeting the requirements of AABC MN-1 or the specifications or drawings shall be clearly indicated on the form and an explanation of all discrepancies shall be provided in test report.

3.2 FUME HOODS

3.3 BATTERY EXHAUST SYSTEMS

All tests and measurements shall be performed in accordance with AABC MN-1 or NEBB-01 for similar exhaust system components. Air flow rates at each exhaust outlet shall be equal quantities, unless otherwise shown, with the system exhaust fan providing the total air flow rate shown.

3.4 CONTROL SYSTEMS

Testing, adjusting, and balancing of the systems shall be coordinated with the control system installation. All control components shall be verified to be properly installed and operating as specified before proceeding with testing, adjusting, and balancing. Verification shall be in accordance with AABC MN-1.

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SECTION 15995

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SECTION 15995

COMMISSIONING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals with "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Commissioning Team; FIO.

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.

SD-06 Instructions

Test Procedures; FIO.

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

SD-07 Schedules

Test Schedule; FIO.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

SD-09 Reports

Test Reports; FIO.

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 15950 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS 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.

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, if applicable
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 Chilled Water and Hot Water Piping Systems

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	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

Pre-commissioning Checklist - Ductwork

For Air Handler: AH-1 and AH-2

Checklist Item	Q	M	E	T	C	D	O	U
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 with installation of each verified by the specified team members initialing each location on a copy of the as-built drawings.	___	___	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	___	___	___

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AH-1 and AH-2

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. (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	___	___	___	___	___

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AH-1 and AH-2

Checklist Item	Q	M	E	T	C	D	O	U
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
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: ATU #1-01 to ATU #2-29

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	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Controls								
a. Reheat terminal/coil controls verified.	___	___	X	X	___	___	___	___
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 - VAV Terminal

For VAV Terminal: ATU #1-01 to ATU #2-29

Checklist Item	Q	M	E	T	C	D	O	U

Pre-commissioning Checklist - Pumps

For Pump: CHWP-1
HWP-1

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	___	___	___
e. Water balance with design maximum flow.	___	___	X	___	X	___	___	___
f. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: CH-1

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 - Packaged Air Cooled Chiller

For Chiller: CH-1

Checklist Item	Q	M	E	T	C	D	O	U

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: B-1

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 gas piping installed.	___	___	X	X	X	___	___	___
f. Boiler gas piping tested.	___	___	X	X	X	___	___	___
g. 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	___	___	___	___

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: B-1

Checklist Item	Q	M	E	T	C	D	O	U
c. Hot water heating system balanced.	___	___	X	X	___	___	___	___
d. Hot water heating controls operational.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan: EF-1, EF-2 and EF-3

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: AH-1 and AH-2

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 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	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Pumps

For Pump: CHWP-1 and HWP-1

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	TAB	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		_____	
Voltage to ground	_____	_____	_____

b. Minimum flow:

Functional Performance Test Checklist - Pumps

For Pump: CHWP-1 and HWP-1

	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 percent.

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. 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 L/S (See Drawing M1.2 for each VAV box)
Minimum flow L/S (See Drawing M1.2 for each VAV box)

(2) Check damper maximum/minimum flow settings.

Maximum flow setting L/S (See Drawing M1.2 for ecah VAV box)
Minimum flow setting L/S (See Drawing M1.2 for each VAV box)

Reheat coil operation range (full open to full closed) 20°C to 22°C

(3) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register).
_____

(4) 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
_____

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: AH-1 and AH-2

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 and return fans operating mode is initiated:

(1) All dampers in normal position [and fan inlet vanes modulate to maintain the required static pressure]. _____

(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 (for AH-2 only).

(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

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AH-1 and AH-2
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.

For CC-1's and CC-2's setting points, see mechanical drawings.

	Max cooling	Min cooling
Supply air volume L/S)	_____	_____
Supply air temp. (_____ degrees C)	_____	_____

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

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: AH-1 and AH-2

_____

Contracting Officer's Representative

_____

Using Agency's Representative

_____

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: CH-1

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 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	TAB	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	_____	_____	_____

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: CH-1

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.

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: B-1

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	TAB	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 concentration	_____	_____	_____
Fuel type	_____	_____	_____
Combustion efficiency	_____	_____	_____

3. Record the following information:

Ambient temperature _____ degrees F
Entering hot water temperature _____ degrees F
Leaving hot water temperature _____ 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. _____

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: B-1

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 - HVAC Controls

For HVAC System: AH-1 and AH-2

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10 percent.

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.

Sensor _____
Manual measurement _____
Panel reading value _____

c. Verify system stability by changing the controller set point as follows:

(1) Air temperature - 5.6 degree C (10 degrees F)

(2) Water temperature - 5.6 degree C (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

_____

Functional Performance Test Checklist - HVAC Controls

For HVAC System: AH-1 and AH-2

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

Functional Performance Test Checklist - HVAC Controls

For HVAC System: AH-1 and AH-2

-- End of Section --

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SECTION 16113

UNDERFLOOR DUCT SYSTEM

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.

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 68	Connection of Terminal Equipment to the Telephone Network

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 498	(1996) Attachment Plugs and Receptacles
UL 870	(1995) Wireways, Auxiliary Gutters, and Associated Fittings
UL 884	(1994) Underfloor Raceways and Fittings
UL 1863	(1995) Communication Circuit Accessories

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Components; GA. Insert Duct; GA. Blank Ducts; GA. Service Outlet Fittings ; GA. Trench Duct; GA.

Data published by the manufacturer to permit verification of the accuracy and completeness of information shown, and 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 of these specifications.

Approval will be based on published literature of the manufacturer, or a certification of compliance issued by the manufacturer as evidence of compliance with these provisions.

SD-04 Drawings

Duct System; GA.

Detail drawings consisting of accurate and complete drawings as required to demonstrate compliance with the applicable provisions of the contract. Drawings shall clearly show the proposed layout of the duct system, including associated conduits and wireways. Drawings shall show connections to equipment or equipment cabinets, panelboards, and related components. Drawing shall be accurately scaled or dimensioned to indicate the proposed layout of the system, construction features of the facility or building, and equipment to be installed which would impact the layout or usage of the duct system. The layout shall ensure the clearances required for the proper operation, maintenance, and use of the system and facility equipment. Details shall be shown to indicate the manufacturer's proposed method of anchorage, leveling, mating and other details of the system, including appurtenances. The exact location of blank ducts, duct markers, inserts, junction boxes, cover plates, service fittings, conduits, wire troughs, and panelboards shall be shown. Each separate item proposed shall be identified by the corresponding item number used on the list of equipment and materials. Distinction shall be made between active, blank, future, or spare features of the duct system.

As-Built Drawing; FIO.

As-built drawings showing features of the complete duct system installed per the approved initial drawings, within 30 calendar days following the completed installation. Any deviations from previously approved drawings shall be indicated on the transmittal form or attachment thereto.

SD-06 Instructions

Duct System; FIO.

Instructions showing the assembly and installation of ducts and duct components, approved prior to beginning any installation work.

SD-07 Schedules

Equipment and Materials; FIO.

A complete itemized listing of individual items of equipment and material proposed for incorporation into the work. Each itemization shall include an item number, the quantity of items required or proposed, the name of the manufacturer of each item, the catalog number or similar ordering information, and the nomenclature shown on published literature of the manufacturer.

SD-14 Samples

Service Outlet Fittings; FIO.

Physical examples of proposed equipment.

SD-19 Operation and Maintenance Manuals

Duct System; FIO.

Six copies of instruction manuals, concurrently with the installation drawings, including specific instructions for locating and installing inserts of the preset and afterset types. Manuals shall include a list of recommended spare parts, a list of tools provided, and any other data or drawings required for the maintenance and future use of the duct system. Manuals shall be in suitable binders properly marked with pertinent contract information, containing dividers and indexes. Revised manuals or updated inserts, adjusted to show as-built conditions shall be furnished within 30 days after installation is complete.

1.3 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been incorporated into underfloor duct systems for at least 2 years prior to the bid opening.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials delivered prior to use shall be stored off the ground within a completely enclosed structure or shall be completely enclosed within a weatherproof covering. Material shall not be unpacked until needed for installation unless specific arrangements have been approved in advance. At time of final inspection of the building, material required to be delivered to the Contracting Officer shall be properly packaged, marked, and stored as directed.

1.5 TOOLS

One complete set of new tools for installing afterset inserts shall be provided. One electric or magnetic devices shall be provided for locating preset inserts. One sets of tools for removing junction box covers shall be furnished.

1.6 SYSTEM DESCRIPTION

A complete underfloor raceway system including interface components shall be provided under this section. Service fittings shall be furnished with receptacles, jacks, or connectors unless otherwise noted. Wiring or cable, if required, will be furnished and installed under other sections of the specifications. Under this section, the wire or cable shall be connected to devices or terminal blocks at the service fittings or shall be extended into the fitting for future connection by others if so indicated on the plans. Power wiring shall be provided in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Communications wiring shall be provided in accordance with Section 16710 PREMISES DISTRIBUTION SYSTEM.

PART 2 PRODUCTS

2.1 COMPONENTS

A complete underfloor duct system shall be furnished. The system shall include blank and insert ducts, junction boxes, supports, elbows, offsets, expansion joints, outlets, conduit, conduit adaptors, connections, and necessary fittings to form a complete installation. Equipment and materials shall be products of a single manufacturer to the extent

practicable.

2.1.1 Coordination - General Requirements

Layout and Contractor selections shall be fully coordinated with the architectural, structural, mechanical, and electrical work throughout all phases of this project including field modifications. The locations of duct shown on plans are intended to be approximate unless dimensions have been included; routings of feeders and interconnections are schematic. The overall configuration, relative proportions and general locations of devices should be maintained. Detailed drawings of the Contractor's proposed system shall be prepared as required under paragraph SUBMITTALS and shall include notes, dimensions, details or other means to show that interfacing with, or accommodation to, other work has been accomplished. Errors or conflicts encountered in the course of the project shall be brought promptly to the Contracting Officer's attention for resolution. When the products of more than one manufacturer will be utilized, the Contractor shall coordinate with the manufacturers to insure that the different products are compatible, that supplemental components are included if necessary, and that the products are installed per the manufacturer's prescribed procedures.

2.1.2 Architectural Considerations

Exposed portions of the system such as junction box covers shall have finish treatments or lay-in materials compatible with the architectural features of the surrounding surfaces. Accessories necessary to accommodate specific finished floor configurations shall be selected and installed in accordance with the recommendations and instructions of the manufacturer. Modifications of standard products, if required, shall be performed by or approved by the manufacturer.

2.2 SYSTEM TYPE

System shall be single level type, and shall consist of single, double, or triple duct as indicated. Duct system shall be located in the structural slab and shall comply with the requirements of UL 884.

2.3 DUCTS - GENERAL

Internal cross section shall be not less than 5161 square millimeters (8 square inches) for ducts shown. Minimum thickness shall be in accordance with Table 5.1 of UL 884. Duct shall be corrosion protected by a coating of zinc or equivalent enamel or organic paint.

2.4 INSERT DUCTS

Ducts shall have preset inserts 305 mm (12 inches) on center over the entire length of each duct. In lieu of standard threaded inserts, threadless elliptical-shaped inserts may be provided.

2.5 BLANK DUCTS

Blank duct (no insert) may be used in lieu of insert duct in permanent corridors, vestibules, passageways, lobbies, and for connecting ducts between parallel ducts less than 1.8 m (6 feet) (center-to-center), and as feeders from the equipment closet or wire cabinet to the first junction box.

2.6 JUNCTION BOXES

Junction boxes shall be of proper size to accommodate the various sizes and number of ducts shown. Single-level junction boxes shall have partitions to isolate the various services, and shall afford access to each compartment through a single handhole.

2.6.1 Cover Plates

Cover plates shall be adjustable before and after concrete is placed. Plates and inner adjusting rings shall be readily removable. Junction boxes in finished areas shall be supplied with adapters or separate holders of a type to receive the architectural floor finish material.

2.7 SERVICE OUTLET FITTINGS

Flush-mounted service fittings shall be corrosion- resistant metal for connection to systems furniture. All service outlet fittings shall be products of a single manufacturer and shall be the manufacturer's standard item. The Contractor shall ensure that the size and orientation of an installed fitting will not interfere with the installation or use of a second outlet fitting located opposite on an adjacent raceway. Outlet fittings shall have ample wiring space to accommodate the quantity of conductors installed at each outlet.

2.7.1 Telephone Outlet Fittings

Outlet fittings for telephone service shall be of a type approved by the Contracting Officer and shall be provided in one or more of the following configurations: jack/plug assembly for connection to systems furniture.

2.7.2 Cable Connector-Type Fittings

Jack-type fittings shall contain duplex jack assemblies conforming to 47 CFR 68. Jacks shall be Universal Service Ordering Code (USOC) 8-pin type RJ-45.

2.8 Communication Circuit Accessories

Communication circuit accessories shall conform to UL 1863.

2.9 Special Communications (Signal) Outlet Fittings

Outlet fittings serving systems furniture shall be as detailed on the plans.

2.13 3 EXECUTION

3.1 DUCT SYSTEM

Quantity, sizes, and arrangement of ducts and accessories shall be as shown on the plans. Separate ducts shall be provided for receptacle power and telephone services. Revisions implemented during construction shall be incorporated into the as-built installation drawings.

3.1.1 Ducts

Ducts shall be accurately aligned and leveled. The distance between the top of ducts and the finished concrete floor shall be as shown. Duct

joints shall prevent entry of concrete or fill. Where fixed dimensions are not indicated, ducts shall be installed in approximate locations shown. Junction boxes and duct lines shall be located to clear permanent and future nonpermanent partitions and foundations for equipment and shall be coordinated with architectural modules. Unless otherwise indicated, ducts located in structural slabs shall be positioned outside the compression zone of the slab. Duct system installation shall comply with the requirements of NFPA 70.

3.1.2 Duct Supports

Metal duct supports shall be located as close as practicable to duct joints, elbows, bends, terminations; and within 750 mm on each side of junction boxes and elsewhere at intervals of not over 1.5 m.

3.1.3 Inserts

Insert height shall be such that top of insert shall be 3 mm below top of finished concrete subfloor . Inserts closest to junction boxes shall be not more than 300 mm (12 inches) from vertical faces of junction boxes. Inserts shall be aligned on the same centers for all services and for duct rows in bays.

3.1.4 Termination

Conduits for power service shall terminate in bottom of panelboards with approved type fittings. Ducts for telephone service shall terminate 50 mm above the floor. Ducts shall be extended into telephone cabinets where required.

3.2 JUNCTION BOXES

3.2.1 Cover Plates

Cover plates shall be leveled flush with finished floor. Square or rectangular plates shall be laid square with wall lines.

3.2.2 Protection

Duct terminations, boxes, plates, and rings shall be protected from damage, distortion, and entry of concrete. Exposed surfaces in finished work areas that are marred during placing of the floor shall be replaced with new items or finished equal to the original. Unused duct or conduit entrances to junction boxes shall be closed with blank closure plates or plugs. Sealant shall be placed on contact surfaces, such as at duct termination and other similar locations, to eliminate entry of concrete or fill material. Boxes shall be held in place, and securely supported during placement of concrete.

3.2.3 Conduit Connections

Conduit shall run below duct wherever necessary to cross a duct run. Conduit extensions shall enter junction boxes at corner, or bottom openings, or at spare duct openings through duct adapters.

3.4 SERVICE OUTLET FITTINGS

3.4.1 Quantity and Location

Service fittings of the type indicated shall be installed at the location shown on the plans. Coordinate with the Contracting Officer to determine actual systems furniture arrangement.

3.4.2 Cutting of Floors

Necessary cutting of floor for the installation of service fittings shall be made as recommended by duct system manufacturer. Floor construction or finish damaged by installation of fittings shall be patched or replaced.

3.4.3 Surplus Fittings

Spare fittings shall be furnished to the Contracting Officer in the following quantities:

Service	Type of Fitting	Number
Telephone	Systems furniture connection	75
Power	Systems furniture connection	75

3.7 BOUNDARIES

3.7.1 Modules

Underfloor ducts shall not be located within 300 mm of structural concrete framing members or window mullion lines, except at concentration points near electric or telephone closets.

3.7.2 Walls

Stub ends of underfloor ducts perpendicular to walls shall be extended as close as practicable to wall line.

3.7.3 Expansion Joints

Expansion joints fittings shall be installed wherever floor duct or trench duct crosses building expansion joints. A bonding strap shall be included to insure ground continuity.

3.8 INSPECTION

Upon completion of the assembly of the underfloor duct system, and before ducts are covered, inspection in the presence of the Contracting Officer shall show ducts, boxes, and other related equipment to be in place. Entire system shall be free of obstructions and moisture after placing concrete. Ducts shall be thoroughly swabbed out before floor finish is applied and wiring is installed.

-- End of Section --

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-- End of Section Table of Contents --

SECTION 16311

MAIN ELECTRIC SUPPLY STATION AND SUBSTATION

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 C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1990) Mechanical Demand Registers
ANSI C12.10	(1987) 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 C29.1	(1988) Electrical Power Insulators - Test Methods
ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.9	(1983) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C37.06	(1987; C37.06a; R 1994) AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Switchgear
ANSI C37.16	(1988; C37.16a) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C37.32	(1990) High-Voltage Air Switches, Bus Supports, and Switch Accessories - Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C37.121	(1989) Switchgear, Unit Substations Requirement

ANSI C39.1	(1981; R 1992) Requirements forElectrical Analog Indicating Instruments
ANSI C57.12.10	(1988) Safety Requirements for Transformers 230 kV and Below 833/958 Through 8333/10 417 kVA, Single-Phase, and 750/862 Through 60 000/80 000/100 000 kVA, Three-Phase Without Load Tap Changing; and 3750/4687 Through 60 000/80 000/100 000 kVA With Load Tap Changing
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 572	(1994b) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 575	(1989) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 633	(1995) Normalized High-Strength Low-Alloy Structural Steel Plates
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 188	(1988) Seamless Copper Bus Pipe and Tube
ASTM B 231	(1990) Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 317	(1995) Aluminum-Alloy Extruded Bar, Rod, Pipe, and Structural Shapes for Electrical Purposes (Bus Conductor)
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 2472	(1992) Sulfur Hexafluoride
ASTM D 4059	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography
ASTM F 883	(1990) Padlocks

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(1993; B31.3a; B31.3b; B31.3c) Chemical Plant and Petroleum Refinery Piping
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.1	(1994) IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control
IEEE C37.2	(1991) Electrical Power System Device Function Numbers
IEEE C37.04	(1979; R 1988, C37.04f; C37.04g; C37.04h; C37.04i) Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.09	(1979; R 1988; C37.09c, C37.09e; C37.09g) Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.13	(1990) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C37.20.2	(1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear
IEEE C37.23	(1987; R 1991) Guide for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus
IEEE C37.30	(1992) Definitions and Requirements for High-Voltage Air Switches, Insulators, and Bus Supports
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches

IEEE C37.41	(1994) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C37.081	(1981; R 1988) Guide for Synthetic Fault Testing of ac High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.90	(1989) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.1	(1989; R 1991) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE C37.98	(1987; R 1991) Seismic Testing of Relays
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.01	(1989) Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin - Encapsulated Windings
IEEE C57.12.11	(1980) Guide for Installation of Oil-Immersed Transformers (10 MVA and Larger, 69-287 kV Rating)
IEEE C57.12.80	(1978; R 1992) Terminology for Power and Distribution Transformers
IEEE C57.12.90	(1993) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
IEEE C57.13	(1993) Instrument Transformers
IEEE C57.15	(1986; R 1992) Requirements, Terminology, and Test Code for Step-Voltage and Induction-Voltage Regulators
IEEE C57.19.00	(1991) IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
IEEE C57.19.01	(1991) IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) 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 C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 32	(1972; R 1991) Requirements, Terminology, and Test Procedure for Neutral Grounding Devices
IEEE Std 80	(1986; R 1991) IEEE Guide for Safety in ac Substation Grounding
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1992) 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 399	(1990) Recommended Practice for Power Systems Analysis
IEEE Std 484	(1987; Incl Std 484A) Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations
IEEE Std 485	(1983) Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations
IEEE Std 525	(1992) IEEE Guide for the Design and Installation of Cable Systems in Substations

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA S18.1	(1979; R 1992) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA LA 1	(1992) Surge Arresters
NEMA PB 1	(1990) Panelboards

NEMA SG 2	(1993) High Voltage Fuses
NEMA SG 3	(1990) Low-Voltage Power Circuit Breakers
NEMA SG 5	(1990) Power Switchgear Assemblies
NEMA SG 6	(1990) Power Switching Equipment
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993; Rev March 96) Rigid Metal Conduit
UL 50	(1995; Rev Oct 1996) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Dec 1993) Panelboards
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486B	(1991; Rev thru Oct 1996) Wire Connectors for Use with Aluminum Conductors
UL 489	(1991; Rev thru Jun 1995) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 1236	(1994; Rev thru Apr 1996) Battery Chargers for Charging Engine-StarterBatteries

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.2.2 System Description

The system shall be configured as specified, and shall include structures, incoming and outgoing lines, transformers, regulators, fuses, circuit breakers, switches, switchgear, and appurtenances to provide a fully functional system.

1.2.3 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions.

a. Seismic Zone four

1.2.4 Incoming and Outgoing Circuit Compliance

Aerial line circuits shall comply with the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Circuits in cable trays shall comply with the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND for cable and with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR for cable trays.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Structural Calculations; GA.

Manufacturer's design analysis and calculations for structures, foundations, anchor bolts, and supports differing from those indicated in the contract drawings, and for prefabricated structures. Calculations shall be made by a registered professional engineer with demonstrated experience in substation structural design in the last three years. The manufacturer shall provide a list of projects complete with points of contact, addresses and telephone numbers.

Fault Current and Protective Devices Coordination Studies; GA.

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.

Battery Calculations; GA.

Calculations for the battery and associated charger indicating the basis used in defining loads, selecting cell types, and determining the battery ampere-hour capacity and physical size. Calculations shall be provided to determine capacity for the battery charger and be similar to those shown in the Appendix to IEEE Std 485, including explanatory data. Calculations for the battery-charger shall demonstrate that the output voltage and current provided are adequate to comply with the preceding requirements.

Manufacturer's Catalog; FIO.

Submit 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; FIO.

A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Procedures; FIO.

As a minimum, the Contractor shall submit installation procedures for station buses and insulators, station structures, transformers, switchgear, battery system, voltage regulators and grounding resistors.

Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

As-Built Drawings; FIO.

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 as well as all 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, 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 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-08 Statements

On-Site Test; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports

Factory Test Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm 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 all equipment used, with calibration certifications.

b. A copy of all 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 all adjustments made.

Field Test Plan; GA.

A detailed description of the Contractor's proposed procedures for on-site tests 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; GA.

Six copies of the information described below in 215.9 by 279.4 mm 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 all equipment used, with calibration certifications.

b. A copy of all measurements taken.

c. The dates of testing.

d. The equipment and values verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of all adjustments made.

h. Final position of controls, and device settings.

SD-13 Certificates

Materials and Equipment; FIO.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories, Inc., (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 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 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 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. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the

specifications.

SD-19 OPERATION AND MAINTENANCE MANUALS

Electric Supply Station; FIO.

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 within 30 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.

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

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

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.

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. As a minimum, nameplates shall be provided for transformers, regulators, circuit breakers, capacitors, meters, switches, switchgear, and grounding resistors.

2.2.2 (null)

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 and ASTM A 123.

2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 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 1.6 mm 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 PAINTING, GENERAL.

2.3.3.1 OUTGOING METAL-CLAD SWITCHGEAR

New circuit breaker unit shall be installed in existing cubicle as indicated.

2.3.3.1.1 Ratings

Main buses are three-phase three-wire with a continuous current rating of 1,200amperes rms. Switchgear ratings at 60 Hz shall be in accordance with ANSI C37.06 and as follows:

Maximum voltage.....15kV

Nominal voltage class..... 12kV

BIL.....95kV

Maximum symmetrical interrupting current.....23kA rms

3-second short-time current.....23kA rms

Continuous current.....1,200 rms

2.4 Circuit Breaker

Circuit breaker shall comply with IEEE C37.04 and ANSI C37.06 and shall consist of items listed for such units in NEMA SG 5. Circuit breaker shall be of the vacuum drawout type having electrically charged, stored-energy mechanism which is mechanically and electrically trip free. A means for manual charging of the trip mechanism shall be provided. The circuit breaker shall have a cell-mounted switch assembly for control and interlocking. In addition to any contacts used or shown, the circuit breaker shall be provided with four spare auxiliary and cell contacts, two normally open and two normally closed, wired to interconnection terminals. If auxiliary relays are used to provide additional contacts, such relays shall not be of the latching type. Interconnection terminal blocks shall be wired to permit remote open and close operations of the circuit breaker and for other required exterior connections or connections between switchgear sections.

2.4.1 Vacuum Circuit Interrupter

Vacuum interrupter shall be hermetically-sealed in a high vacuum to protect contacts from moisture and contamination. Circuit breaker shall have provisions for maintenance slow closing of contacts and have a readily accessible contact wear indicator. Circuit breaker unit shall match existing switchgear equipment.

2.4.1.1 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.

2.4.1.1.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the nearest upstream device in the existing source system and extend through the downstream devices at the load end.

2.5 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented.

2.6 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.

2.7 Fault Current Analysis

2.7.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.7.2 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.

2.7.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line, 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.

2.8 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 the 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 changes (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.9 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 existing power system data including time-current characteristic 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.

2.10 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.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2.

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 EQUIPMENT INSTALLATION

3.5 FIELD TESTING

3.5.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 30 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. All field test reports will be signed and dated by the Contractor.

3.5.2 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.

3.5.3 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 two years of current product experience. No part of the electrical system shall be energized until all station grounding components have been tested and demonstrated to comply with the specified requirements. 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 station buses and 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 caused 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 during installation or shipment and to verify 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. 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 include, but are not limited to, are the following:

Breakers, circuit.

3.5.4 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 requirements herein. An operating test report shall be submitted in accordance with paragraph TEST REPORTS.

3.6 MANUFACTURER'S FIELD SERVICE

3.6.2 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.

3.7 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 --

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SECTION 16370

ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

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 C29.1	(1988) Electrical Power Insulators - Test Methods
ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	(1986) Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(1989) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	(1984; R 1991) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1984) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI C29.8	(1985) Wet-Process Porcelain Insulators - Apparatus, Cap and Pin Type
ANSI C29.9	(1983) Wet-Process Porcelain Insulators - Apparatus, Post-Type
ANSI C37.32	(1990) High-Voltage Air Switches, Bus Supports, and Switch Accessories - Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide
ANSI C57.12.20	(1994) Transformers, Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 Volts and Below; Low Voltage, 7970/13 800Y Volts and Below
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.2	(1987) 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 C135.17	(1988) Insulator Pins with Lead Threads for Overhead Line Construction Galvanized Ferrous Bolt-Type
ANSI C135.22	(1988) Galvanized Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI C135.33	(1988) Crossarm Gains, Galvanized Ferrous
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994) Carbon Structural Steel
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 475	(1995) Zinc-Coated Steel Wire Strand
ASTM A 575	(1989) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 1	(1990) Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 228	(1993) Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B 230	(1989) Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B 231	(1990) Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B 232	(1992) Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B 398	(1990) Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B 399	(1992) Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B 416	(1993) Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environment
ASTM D 4059	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography.
ASTM F 883	(1990) Padlocks

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C4	(1995) Poles - Preservative Treatment by Pressure Processes
AWPA C25	(1995) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA P1/P13	(1995) Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)
AWPA P5	(1995) Standards for Waterborne Preservatives
AWPA P8	(1995) Standards for Oil-Borne Preservatives
AWPA P9	(1992) Standards for Solvents and Formulations for Organic Preservative Systems

CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC)

CPUC G.O.95	(1997) Rules for Overhead Electrical Line Construction

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches

IEEE C37.41	(1994) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C37.60	(1981; R 1992) Requirements for Overhead, Pad Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for ac Systems
IEEE C37.63	(1984; R 1990) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13.2	(1991) IEEE Standard Conformance Test Procedures for Instrument Transformers
IEEE C57.15	(1986; R 1992) Requirements, Terminology, and Test Code for Step-Voltage and Induction-Voltage Regulators
IEEE C57.19.00	(1991) IEEE Standard General Requirements and Test Procedures for Outdoor Power Apparatus Bushings
IEEE C57.19.01	(1991) IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) 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 C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 18	(1980; R 1993) Shunt Power Capacitors
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1992) 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 399	(1990) Recommended Pratice for Power Systems Analysis
IEEE Std 404	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V Through 46 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V

INSULATED CABLE ENGINEERING ASSOCIATION (ICEA)

ICEA S-70-547	(1992) Weather Resistant Polyolefin Covered Wire and Cable

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems
NEMA HV 2	(1984; R 1991) Application Guide for Ceramic Suspension Insulators
NEMA LA 1	(1992) Surge Arresters
NEMA SG 2	(1993) High Voltage Fuses
NEMA WC 5	(1992; Rev 1) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 7	(1993) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

RURAL ELECTRIFICATION ADMINISTRATION (REA)

REA Bulletin 1728H-701	(1993) REA Specification for Wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys

UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (1991; Rev thru Oct 1996) 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.

e. Seismic Zone: 4

f. Corrosive Areas: Salt air.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Device Coordination Study; GA.

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 settings, ratings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog; FIO.

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; FIO.

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.

SD-04 Drawings

Electrical Distribution System; FIO.

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:

b. Poles.

d. Crossarms.

h. Conductors.

i. Insulators.

j. 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; FIO.

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-09 Reports

Factory Test; FIO.

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; FIO.

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.

Test Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm (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-13 Certificates

Materials and Equipment; FIO.

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 Electronic 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-19 OPERATION AND MAINTENANCE MANUALS

Electrical Distribution System; FIO.

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.

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.

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 and ASTM A 123.

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 120 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 1.6 mm 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 PAINTING, GENERAL.

2.5 CONDUCTORS, CONNECTORS, AND SPLICES

2.5.2 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

2.5.3 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors,

and 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.

2.8 POLES AND HARDWARE

2.8.1 Wood Poles

Existing wood poles shall be used for installation of new conductors.

2.8.2 Pole Line Hardware

Zinc-coated hardware shall comply with ANSI C135.1, ANSI C135.2, ANSI C135.4, ANSI C135.14, ANSI C135.17, ANSI C135.22, and ANSI C135.33. Steel hardware shall comply with ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153. 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 57.2 mm square and 4.8 mm (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.

2.8.4 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 3 strand. Guy material shall be Class A zinc-coated-steel utilities grade , with a minimum breaking strength not less than 26.7 kN (6000 pounds) , except where two or more guys are used to provide the required strength. Guy rods shall be not less than 2.1 m (7 feet) in length by 15.9 mm (5/8 inch) [in diameter.

2.9 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.

2.9.1 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 and aluminum alloy for aluminum-composition 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
6 kV to 15 kV	57-2 or 12	56-3	Two 52-3 or 4

2.9.3 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 54-2 for lines of 6 kV to 15 kV.

2.9.4 Apparatus Insulators

Apparatus insulators shall comply with IEEE C57.19.00, IEEE C57.19.01, ANSI C29.8, and ANSI C29.9 as applicable.

2.10 CROSSARM ASSEMBLIES

2.10.1 Crossarms

Crossarms shall comply with REA Bulletin 1728H-701 and shall be solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWPA C25, and a 6.4 mm (1/4 inch), 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 108.0 mm (4-1/4 inches) in height by 82.6 mm (3-1/4 inches) in depth in accordance with IEEE C2 for Grade B construction. Crossarms shall be 3.1m (10 foot) in length. 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 2.5 mm per 304.8 mm (1/10 inch per foot) of length. Bend or twist shall be in one direction only.

2.10.2 Crossarm Gains

Crossarm gains shall comply with ANSI C135.33.

2.13 FUSES AND SWITCHES, MEDIUM-VOLTAGE

2.13.1 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 normal -duty type . 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.

2.13.2 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, IEEE C62.2, 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 7.65 kV mcov. 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. Arresters shall be suitable for installation on a grounded neutral system.

2.13.4 GROUNDING AND BONDING

2.13.4.1 Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467] not less than 19.1 mm (3/4 inch) in diameter by 3.1 meter (10 feet) in length of the sectional type driven full length into the earth.

2.13.4.2 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.

2.13.6 WARNING SIGNS

Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with IEEE C2.

2.13.8 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 10 days before the equipment is ready for testing.

f. High-Voltage Fuses: Manufacturer's standard tests in accordance with IEEE C37.41.

g. Electric Power Insulators: Manufacturer's standard tests in

accordance with ANSI C29.1.

2.13.9 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 list of references complete with points of contact, address and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

2.13.9.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the nearest upstream device in the existing source system and extend through the downstream devices at the load end.

2.13.9.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective deice shall be determined and documented.

2.13.9.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformer 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 transformer 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.

2.13.9.4 Fault Current Analysis

2.13.9.5 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242 and IEEE Std 399.

2.13.9.6 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.

2.13.9.7 Fault Current Availability

Balanced three-phased 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.

2.13.9.8 Coordination Study

The study shall demonstrate that the maximum possible degree of selectively 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 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.

2.13.9.9 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 existing power system data including time-current characteristics 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 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 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 light loading districts, Grade B construction per CPUC G.O. 95. 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.

3.3 CROSSARM MOUNTING

Crossarms shall be bolted to poles with 15.9 mm (5/8 inch) through-bolts with square washers at each end. Bolts shall extend not less than 3 mm nor more than 50 mm beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. rossarm braces shall be provided on crossarms. Flat braces may be provided for 2.4 m (8 foot) crossarms and shall be 6.4 by 31.8 mm (1/4 by 1-1/4 inches), not less than 700 mm (28 inches) in length. Flat braces shall be bolted to arms with 9.5 mm (3/8 inch) carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 50.8 by 101.6 mm (1/2 by 4 inch) lag screws after crossarms are leveled and aligned. Angle braces are required for 3.1 m (10 foot) crossarms and shall be 1.5 m (60 inch) span by 457.2 mm (18 inch) drop formed in one piece from 38.1 by 38.1 by 4.8 mm (1-1/2 by 1-1/2 by 3/16 inch) angle. Angle braces shall be bolted to crossarms with 50.8 mm (1/2 inch) bolts with round or square washers between boltheads and crossarms, and secured to poles with 15.9 mm (5/8 inch) through-bolts. Double crossarms shall be securely held in position by means of 15.9 mm (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

Line 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. 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.

3.4 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 27 kN (6000 pounds). Guy clamps 152.4 mm (6 inches) in length with three 15.9 mm (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 2.4 m (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 inhibiter applied before making a compression connection. Connectors which are factory-filled with an inhibiter are acceptable. Inhibiters 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.

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

TABLE II

TIE-WIRE REQUIREMENTS

CONDUCTOR Copper (AWG)	TIE WIRE Soft-Drawn Copper (AWG)
1 through 3/0	4
4/0 and larger	2

AAC, AAAC, or ACSR (AWG)	AAAC OR AAC (AWG)
Any size	6 or 4

3.5.5 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 guards to cable terminations. Conduits shall be secured to poles by [conduit supports] [two-hole galvanized steel pipe straps] spaced not more than 3 m apart and with one support not more than 300 mm 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.

3.5.6 CONNECTIONS TO BUILDINGS

3.5.6.2 Underground Services

Connections to buildings shall be made at the point indicated and shall be terminated at the service entrance equipment terminals. Cable pulling shall be in accordance with Section 16375, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Service entrance conduits with termination fittings and conductors within the building shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

3.5.7 GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaires, medium-voltage cable terminations 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.

3.5.7.1 Grounding Electrodes

Grounding electrodes shall be installed as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods

shall be located approximately 900 mm out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade. Multiple rods shall be evenly spaced at least 3 m apart and connected together 600 mm below grade with a minimum No. 6 bare copper conductor.

d. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 25 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, 3 m (10 feet) rods spaced a minimum of 3 m (10 feet) apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 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.

3.5.7.2 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.

3.5.7.3 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. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 600 mm. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

3.5.8 FIELD TESTING

3.5.8.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 30 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.

3.5.8.2 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.

3.5.8.3 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.

3.5.8.5 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.

3.5.8.7 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.

3.5.10 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 --

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SECTION 16375

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SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

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 C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1990) Mechanical Demand Registers
ANSI C12.10	(1987) 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 C29.1	(1988) Electrical Power Insulators - Test Methods
ANSI C37.16	(1988; C37.16a) 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) Switchgear, Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures
ANSI C37.72	(1987) Manually-Operated Dead-Front, Padmounted Switchgear with Load-Interrupting Switches and Separable Connectors for Alternating-Current Systems
ANSI C37.121	(1989) Switchgear, Unit Substations Requirements
ANSI C57.12.13	(1982) Conformance Requirements for Liquid-Filled Transformers Used in Unit Installations, Including Unit Substations
ANSI C57.12.21	(1980) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)

ANSI C57.12.26	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
ANSI C57.12.27	(1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations
ANSI C57.12.28	(1988) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity
ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 478	(1994) Precast Reinforced Concrete Manhole Sections
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2472	(1992) Sulfur Hexafluoride
ASTM D 4059	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

ASTM F 883	(1990) Padlocks

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994) Specifications for Cross-linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1987; Rev Mar 1989) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

CALIFORNIA PUBLIC UTILITIES COMMOSSION (CPUC)

CPUC G.O. 128	Rules for Construction of Underground Electric Supply and Communications System

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1995; Supple I; Supple II; Supple III) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.1	(1994) IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control
IEEE C37.2	(1991) Electrical Power System Device Function Numbers
IEEE C37.13	(1990) Low-Voltage AC Power Circuit Breakers Used in Enclosures
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	(1987) 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	(1992) Definitions and Requirements for High-Voltage Air Switches, Insulators, and Bus Supports
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches
IEEE C37.41	(1994) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole

	Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C37.63	(1984; R 1990) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems
IEEE C37.90	(1989) Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.1	(1989; R 1991) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
IEEE C37.98	(1987; R 1991) Seismic Testing of Relays
IEEE C57.12.00	(1993) IEEE 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
IEEE C62.1	(1989; R 1994) 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 C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 48	(1996) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1992) 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	(1990) Recommended Practice for Industrial and Commercial Power System Analysis
IEEE Std 404	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 46

	000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
IEEE Std 590	(1977; R 1991) IEEE Cable Plowing Guide
IEEE Std 592	(1990) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA BU 1	(1994) Busways
NEMA FB 1	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA LA 1	(1992) Surge Arresters
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1989) Deadfront Distribution Switchboards
NEMA SG 2	(1993) High Voltage Fuses
NEMA SG 3	(1990) Low-Voltage Power Circuit Breakers
NEMA SG 5	(1990) Power Switchgear Assemblies
NEMA TC 5	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 7	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
NEMA WC 7	(1993) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993; Rev March 96) Rigid Metal Conduit
UL 198C	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1991; Rev thru Oct 1996) Wire Connectors for Use with Aluminum Conductors
UL 489	(1996) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 510	(1994) Insulating Tape
UL 514A	(1996) Metallic Outlet Boxes
UL 651	(1995) Schedule 40 and 80 Rigid PVC Conduit
UL 854	(1996; Rev May 1996) Service-Entrance Cables
UL 857	(1994; Rev Oct 1994) Busways and Associated Fittings
UL 1242	(1996) Intermediate Metal Conduit
UL 1684	(1993) Reinforced Thermosetting Resin Conduit

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:

f. Seismic Zone: 4

h. Corrosive Areas: Salt Air

1.3 SUBMITTALS

Governmental approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Devices Coordination Studies; GA.

The study shall be submitted with protective device equipment submittals. Not 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.

Manufacturer's Catalog Data; FIO.

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; FIO.

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.

Installation Procedures; GA.

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-04 Drawings

Electrical Distribution System; FIO.

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.

g. Surge arresters.

As-Built Drawings; FIO.

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-09 Reports

Factory Test; FIO.

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; GA.

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.

Test Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm (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 Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm (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-13 Certificates

Materials and Equipment; FIO.

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 Splicer Qualification; FIO.

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; FIO.

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-19 OPERATION AND MAINTENANCE MANUALS

Electrical Distribution System; GA.

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.

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 liters 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.

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 and ASTM A 123.

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 120 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 1.6 mm (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 PAINTING, GENERAL.

2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Conductor Material

Underground cables shall be of soft drawn copper conductor material.

2.4.2 Medium-Voltage Cables

2.4.2.1 General

Medium voltage cables shall conform to the requirements of NEMA WC 8 for cables utilizing ethylene-propylene-rubber (EPR) insulation. Cables shall be in accordance with the requirements of NFPA 70.

2.4.2.2 Insulation

Cables shall utilize ethylene-propylene-rubber (EPR) insulation. Cables shall be provided with 133 percent insulation level .

2.4.2.3 Jackets

Cables shall be provided with a nonmetallic jacket.

2.4.2.4 Neutrals

Neutral conductors of grounded neutral systems shall be of the same insulation material as phase conductors, except that a 600-volt insulation rating is acceptable.

2.4.2.5 Shielding

Cables rated for above 2 kV shall have both conductor and insulation shielding for each phase.

2.4.2.6 Ratings

Medium-voltage cables shall be rated for a circuit voltage of 15 kV .

2.4.3 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70. Cables shall utilize ethylene-propylene-rubber (EPR) insulation and shall conform to the requirements of NEMA WC 8.

2.4.3.2 In Duct

Cables shall be single-conductor cable, Type RHW, THW, THWN, TW, USE, or XHHW 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 heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure-filled type utilizing a plastic-tape mold is acceptable. 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 or Class 2; 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, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 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.

2.5.4.2 Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 510 long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2.6 CONDUIT AND DUCTS

Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage lines. Low-voltage lines run elsewhere may be direct-burial, thick-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

2.6.2.2 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

2.6.2.3 Direct Burial

UL 651 Schedule 80, or NEMA TC 6 Type DB.

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 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (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. 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 69 MPa (10,000 psi) and a flexural strength of at least 34.5 MPa (5000 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.

2.8 POLES AND HARDWARE

Poles and hardware shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

2.9 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 15 kV between phases for 133 percent insulation level.

2.9.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the radial type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

2.9.2 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, drawout, dry-well-mounted, current-limiting fuses, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert

2.9.4 Transformer Tank Sections

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type. Transformers shall be suitable for outdoor use and shall have 2 separate copper windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity .....1500 kVA.

Impedance .....5.75%.

Temperature Rise .....65 degrees C.

High-voltage winding .....12000 volts.

High-voltage winding connections .....Delta.

Low-voltage winding .....277/480 volts.

Low-voltage winding connections ..... Wye.

2.9.5 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

2.9.2.5 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

2.10 Pad-Mounted, Metal-Enclosed, Switchgear

The switchgear shall be configured with 2 incoming compartments for loop-feed arrangement, equipped with air-insulated, load-interrupter switches, as indicated. The outgoing compartments shall be provided with fused disconnects, as indicated.

2.10.1 Ratings at 60 Hz shall be:

Nominal voltage (kV) .....14.4.

Rated maximum voltage (kV) .....17.0.

Rated continuous current (A) .....600.

Maximum symmetrical interrupting capacity (kA) .....14.

Maximum asymmetrical interrupting capacity (kA) .....13.

BIL (kV) .....95.

2.10.2 Operators, Devices, and Controls

Operators and controls shall be provided for the switchgear as follows:

a. Switches shall be provided with a manual, handle-type operator mechanism, utilizing a store-energy (spring-driven) mechanism to simultaneously open or close all phases. The switchgear shall be configured so that the switch actuator is padlockable, but may be accessed without opening the switch compartment doors.

b. Fused disconnects shall be hook-stick operated.

2.10.3 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.

2.12 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 distribution class, rated as shown. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type.

2.13 GROUNDING AND BONDING

2.13.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 19 mm (3/4 inch)] in diameter by 3.1 m (10 feet) in length. Sectional type rods may be used.

2.13.2 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.

2.14 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

2.16 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825 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.

2.16.1 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.

2.16.2 Fireproofing Tape

Fireproofing tape shall be at least 50 mm (2 inches) wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

2.16.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 0.254 mm (10 mil)

thick, conforming to UL 510.

2.17 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 50 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 50 ppm shall be replaced.

2.18 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 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

a. Transformers: Manufacturer's standard routine 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.

g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.

2.20 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.

2.20.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the nearest upstream device in the existing source system and extend through the downstream devices at the load end.

2.20.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented.

2.20.3 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.

2.20.4 Fault Current Analysis

2.20.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.20.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedances shall be those proposed. Data shall be document in the report.

2.20.5 Coordinated Study

The study shall demonstrate that the maximum possible degree of selectively 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 the log-log graph paper.

2.20.6 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 existing power system data including time-current characteristic 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 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 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70, CPUC G.O. 128, 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 manufacturers 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 6.4 mm (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 131 cubic centimeters (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 10 degrees C (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

Medium-voltage cables shall be installed in duct lines where indicated. 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.

3.2.5 Electric Manholes

Cables shall be routed around the interior walls 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.

3.3 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.

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.

3.4.2 Sprayable Method

Manholes shall be power ventilated until coatings are dry and dewatered and the coatings are cured. Ventilation requirements shall be in accordance

with the manufacturer's instruction, but not less than 10 air changes per hour shall be provided. Cable coatings shall be applied by spray, brush, or glove to a wet film thickness that reduces to the dry film thickness approved for fireproofing by FM P7825. Application methods and necessary safety precautions shall be in accordance with the manufacturers instructions. After application, cable coatings shall be dry to the touch in 1 to 2 hours and fully cured in 48 hours, except where the manufacturer has stated that because of unusual humidity or temperature, longer periods may be necessary.

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 100 mm per 30 m. 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 450 mm (18 inches) for ducts of less than 80 mm (3 inch) diameter, and 900 mm (36 inches) for ducts 80 mm (3 inches) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m 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 requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 150 mm (6 inches) in diameter shall be determined by calculation and as shown on the drawings. 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. At any point tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm vertically.

3.5.4 Nonencased Direct-Burial

Top of duct lines shall be not less than _600____ mm below finished grade and shall be installed with a minimum of 75 mm of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 150 mm. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3.5.5 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.

3.5.5.2 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.

3.5.6 Duct Line Markers

A 0.127 mm (5 mil) brightly colored plastic tape, not less than 75 mm (3 inches) in width and suitably inscribed at not more than 3 m (10 feet) on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm (1 mil) metallic foil core to permit easy location of the duct line, shall be placed approximately 300 mm below finished grade.

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 15 mm 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 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.

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.

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 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 15 mm above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage" and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

3.6.6 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 100 mm 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.

3.7.1 Concrete Pads

3.7.1.1 Construction

Concrete pads for pad-mounted electrical equipment may be either pre-fabricated or 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 100 mm above finished paving or grade and sloped to drain. Edges of concrete pads shall have 20 mm 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 20 MPa compressive strength and comform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 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. Padlocks shall be keyed as directed by the Contracting Officer. Padlocks shall comply with ASTM F 883, Type EPC, Size 2.

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 guards to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 3 m apart and with 1 strap not more than 300 mm 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. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the conduit or guard.

3.9 CONNECTIONS TO BUILDINGS

Cables shall be extended into building as indicated. Interfacing with

building interior conduit systems shall be at conduit stubouts terminating 1.5 m outside of a building and 600 mm 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, 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 300 mm below finished grade.

c. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 300 mm, plus or minus 75 mm, below finished top of soil grade. Ground ring conductors shall be No. 2 AWG, minimum.

d. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors. The additional electrodes will be up to three, 3 m (10 feet) rods spaced a minimum of 3 m apartcoupled and driven with the first rod. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 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 50 mm above and 150 mm 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.

3.10.7 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 600 mm.

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 _30____ 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] [each grounding electrode system] [the ground mat] [the ground ring] 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 - 25 ohms.

b. Multiple rod electrodes - 25 ohms.

c. Ground ring - 25 ohms.

3.11.4 Ground-Mat Connection Inspection

All below-grade ground-mat connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 24 hours before the site is ready for inspection.

3.11.5 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 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or 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.

3.11.6 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 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)

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.11.7 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.

3.11.8 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:

b. Pad-mounted transformers

3.11.9 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.

3.13 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.

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SECTION 16415

ELECTRICAL WORK, INTERIOR

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 C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C12.10	(1987) 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 C37.16	(1988; C37.16a; R 1995) 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 C57.12.10	(1987) Safety Requirements for Transformers 230 kV and Below 833/958 Through 8333/10417 kVA, Single-Phase, and 750/862 Through 60 000/80 000/100 000 kVA, Three-Phase Without Load Tap Charging; and 3750/4687 Through 60 000/80 000/100 000 kVA With Load Tap Charging
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 C57.12.50	(1981; R 1989) Ventilated Dry-type Distribution Transformers 1 to 500 kVA, Single-Phase; and 15 to 500 kVA, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts

ANSI C57.12.51	(1981; R 1989) Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts
ANSI C57.12.52	(1981; R 1989) Sealed Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts
ANSI C57.12.70	(1978; R 1993) Terminal Markings and Connections for Distribution and Power Transformers
ANSI C80.5	(1995) Rigid Aluminum Conduit
ANSI C82.1	(1985; C82.1a; C82.1b; C82.1c; R 1992) Specifications for Fluorescent Lamp Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1990) Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992) Laminated Thermosetting Materials
ASTM D 4059	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment

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 C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.12.80	(1978; R 1992) Terminology for Power and Distribution Transformers
IEEE C57.12.90	(1993) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
IEEE ANSI/IEEE C57.13	(1993) Instrument Transformers
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C57.100	(1986; R 1992) Test Procedure for Thermal Evaluation of Oil-Immersed Distribution Transformers
IEEE C62.41	(1991) Surge Voltages in Low-Voltage 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 242	(1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE Std 399	(1990) Recommended Practice for Industrial and Commercial Power Systems Analysis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA BU 1	(1994) Busways
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, Overload Relays Rated Not More Than 2,000 Volts AC or 750 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	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA PE 5	(1985; R 1991) Utility Type Battery Chargers
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA SG 3	(1995) Low-Voltage Power Circuit Breakers
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA TC 13	(1993) Electrical Nonmetallic Tubing (ENT)
NEMA VE 1	(1991) Metal Cable Tray Systems
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code
NFPA 101	(1997) Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

UL-03	(1996; Supple) Electrical Construction Materials Directory
UL 1	(1993; Rev thru Jan 1995) Flexible Metal Conduit

UL 4	(1986; Rev thru Nov 1990) Armored Cable
UL 5	(1995) Surface Metal Raceways and Fittings
UL 6	(1993; Rev Mar 1996) Rigid Metal Conduit
UL 20	(1995; Rev thru Apr 1997) General-Use Snap Switches
UL 44	(1997) Thermoset-Insulated Wires and Cables
UL 50	(1995; Rev Oct 1996) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Dec 1993) Panelboards
UL 83	(1996) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; R Oct 1995) Enclosed and Dead-Front Switches
UL 198B	(1995) Class H Fuses
UL 198C	(1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types
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 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 198L	(1995; Rev May 1995) D-C Fuses for Industrial Use
UL 360	(1996; Rev Mar 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997) Wire Connectors for Use with Aluminum Conductors
UL 486C	(1997) 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 May 1997) Molded-Case Circuit

	Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996) Attachment Plugs and Receptacles
UL 506	(1994; Rev Jul 1994) Specialty Transformers
UL 508	(1993) Industrial Control Equipment
UL 510	(1994) Insulating Tape
UL 512	(1993; R Dec 1995) Fuseholders
UL 514A	(1996) Metallic Outlet Boxes
UL 514B	(1996) Fittings for Conduit and Outlet Boxes
UL 514C	(1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 542	(1994; Rev May 1997) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 651	(1995; Rev Jan 1997) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev Sep 1996) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 674	(1994; Rev thru Feb 1997) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 698	(1995; Rev thru Dec 1996) Industrial Control Equipment for Use in Hazardous (Classified) Locations
UL 719	(1996) Nonmetallic-Sheathed Cables
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 817	(1994; Rev thru Feb 1997) Cord Sets and Power-Supply Cords
UL 844	(1995; Rev thru Aug 1996) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 854	(1996; Rev May 1996) Service-Entrance Cables
UL 857	(1994; Rev thru Nov 1996) Busways and Associated Fittings

UL 869A	(1993; Rev Apr 1994) Reference Standard for Service Equipment
UL 877	(1993; Rev Jul 1995) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Jan 1997) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 891	(1994; Rev thru Jan 1995) Dead-Front Switchboards
UL 924	(1995; Rev thru May 95) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Apr 1997)Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru Mar 1997)Ground-Fault Circuit Interrupters
UL 1004	(1994; Rev thru Feb 1997) Electric Motors
UL 1010	(1995; Rev thru Dec 1996)Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1022	(1994) Line Isolation Monitors
UL 1029	(1994; Rev Sep 1995) High-Intensity-Discharge Lamp Ballasts
UL 1047	(1995) Isolated Power Systems Equipment
UL 1236	(1994; Rev thru Apr 1996) Battery Chargers for Charging Engine-Starter Batteries
UL 1242	(1996) Intermediate Metal Conduit
UL 1449	(1985; Errata Apr 1986) Transient Voltage Surge Suppressors
UL 1564	(1993; Rev Apr 1994) Industrial Battery Chargers
UL 1569	(1995) Metal-Clad Cables
UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1991; Rev thru Mar 95) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Sep 96) High Intensity Discharge Lighting Fixtures
UL 1660	(1994) Liquid-Tight Flexible Nonmetallic Conduit

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 herein 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 located to avoid interference with mechanical or structural features; 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 electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

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.

1.2.3.3 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 6.4 mm High Letters	Minimum 3.2 mm High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

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 two sets of as-built drawings to the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Fault Current and Protective Device Coordination Study; GA.

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; FIO.

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; FIO.

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; FIO.

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

SD-04 Drawings

Interior Electrical Equipment; GA.

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. Motors and rotating machinery.

e. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.

f. 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.

As-Built Drawings; FIO.

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.

SD-08 Statements

On-Site Test; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports

Factory Test Reports; GA.

Six copies of the information described below in 216 x 280 mm 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; GA.

A detailed description of the Contractor's proposed procedures for on-site 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; GA.

Six copies of the information described below in 216 x 280 mm 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-13 Certificates

Materials and Equipment; GA.

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.

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.

2.2 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. Conductors indicated to be No. 6 AWG or smaller diameter shall be copper. Conductors indicated to be No. 4 AWG and larger diameter shall be either copper or aluminum, unless otherwise indicated or required by manufacturer.

2.2.1 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.

2.2.2 Aluminum Conductors

Aluminum conductors shall be AA-8000 series electrical grade aluminum alloy conductors. Type EC-1350 aluminum is unacceptable.

2.2.3 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] or RHW conforming to UL 44], 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.

2.2.4 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.

2.2.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.2.7 Cord Sets and Power-Supply Cords

UL 817.

2.3 CABLE TRAYS

NEMA VE 1 cable trays shall form a wireway system, and shall be of nominal 100 mm 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 610 mm.

2.3.1 Trough

Trough-type cable trays shall be of a nominal 300 mm width.

2.3.2 Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

2.4 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 ratings shall be 120/208 volts rms, operating voltage; 60 Hz; 3-phase; 4 wire with ground; transient suppression voltage (peak let-through voltage) of 800 volts. Fuses shall not be used as surge suppression.

2.5 CIRCUIT BREAKERS

2.6 MOLDED-CASE CIRCUIT BREAKERS

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.

2.6.1 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.

2.6.2 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 coly, ointed 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. Fixed long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. Fixed short-time delay.

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.

h. Fixed ground-fault delay.

j. ground-fault trip indicators shall be provided.

2.6.5 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."

2.8 CONDUIT AND TUBING

2.8.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

2.8.4 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

2.8.5 Intermediate Metal Conduit

UL 1242.

2.8.8 Rigid Metal Conduit

UL 6.

2.9 CONDUIT AND DEVICE BOXES AND FITTINGS

2.9.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514C.

2.9.5 Fittings for Conduit and Outlet Boxes

UL 514B.

2.9.6 CONNECTORS, WIRE PRESSURE

2.9.6.1 For Use With Copper Conductors

UL 486A.

2.9.6.2 For Use With Aluminum Conductors

UL 486B.

2.9.7 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.9.7.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not 19.1 mm in diameter by 3.1 meter in length of the sectional type driven full length into the earth.

2.9.7.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.9.8 ENCLOSURES

2.9.8.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 0.0164 cubic meters shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.9.8.2 Circuit Breaker Enclosures

UL 489.

2.9.9 FIXTURES, LIGHTING AND FIXTURE ACCESSORIES/COMPONENTS

Standard Drawing 40-06-04 sheets referenced hereinafter and enclosed as an integral part of these specifications, additional fixtures shown on contract drawings, if any, and UL 844 for fixtures to be installed in hazardous (classified) locations. Fixtures, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

2.9.9.1 Fixture, Auxiliary or Emergency

UL 924.

2.9.9.2 Incandescent Fixture

NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1571.

2.9.9.3 Fluorescent

(1) Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1570. 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.

(2) Electronic Ballast. Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet 47 CFR 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway, and are identically controlled.

(a) Light output regulation shall be +/- 10%.

(b) Voltage input regulation shall be +/- 10%.

(c) Lamp current crest factor shall be no more than 1.6.

(d) Ballast factor shall be not less than 85% nor more than 100%, unless otherwise indicated.

(e) A 60 Hz filter shall be provided. Flicker shall be no more than 10% with any lamp suitable for the ballast.

(f) Ballast case temperature shall not exceed 25 degree Celsius rise above 40 degree Celsius ambient, when tested in accordance with UL 935.

(g) Total harmonic distortion shall be in the range of 10-20%.

(h) Power factor shall not be less than 0.95.

(i) Ballasts shall operate at a frequency of 20 kHz or more.

(j) Operating filament voltage shall be 2.5 to 4.5 volts.

(k) Warranty. Three year full warranty including a $10 labor allowance.

(l) Ballast Efficacy Factor (BEF) shall be in accordance with the following table. Ballasts and lamps shall be matching rapid start or instant start as indicated on the following table. If 32W-F32-T8 lamps and ballasts are used, they must be either all rapid start or all instant start.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS*

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL INPUT VOLTAGE	NUMBER OF LAMPS	MIN. BALLAST EFFICACY FACTOR
40W F40 T12	rapid start	120 or 277 V	1	2.3
			2	1.2
			3	0.8
			4	0.6
34W F40 T12	rapid start	120 or 277 V	1	2.6
			2	1.3
			3	1.0
			4	0.7
40W F40 T10	rapid start	120 or 277 V	1	2.2
			2	1.1
			3	0.8
32W F32 T8	rapid or instant start	120 or 277 V	1	2.4
			2	1.4
			3	1.0
			4	0.8

*For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

BEF = Ballast Factor (in percent) / Power Input

Where Power Input = Total Wattage of Combined Lamps and Ballasts.

FLUORESCENT LAMP DIMMING SYSTEMS

General

1. The fluorescent lamp dimming systems shall consist of compatible dimming controls, fluorescent dimming ballasts and standard rapid start lamps.

2. The dimming controls manufacturer's published literature shall list the recommended dimming ballasts by dimming ballast manufacturer and catalog number and conversely the dimming ballast manufacturer's published literature shall list the recommended dimming controls by dimming controls manufacturer and catalog number.

3. The dimming controls shall have been examined and approved by Underwriters Laboratories. Inc., (UL) in the course of the component recognition (yellow card) extended to the dimming ballasts.

4. Ballasts or lamps of different brand manufacturer shall not be intermixed on the same dimming control.

5. Reduced wattage energy saving lamps shall not be used with dimming ballasts.

6. Fluorescent fixtures with dimming ballasts shall be furnished with premium circuit interrupting lampholders with knife edge contacts rather than leaf spring contacts.

7. Fluorescent dimmers shall provide a dimming ratio 200 to 1.

2.9.9.3.1 Wall Box Type

a. Wall box type fluorescent dimmers shall be solid state type, rated for the circuit as required by the dimming ballast manufacturer.

b. Dimmers shall be calibrated linear slide type control and shall include a positive on-off switch. Both the on-off switch and the dimming mechanism shall be silent in operation.

c. The solid state dimming circuit shall be voltage stabilized so that light output is unaffected by changes in input line voltage.

d. Dimmers shall include special circuitry to suppress interference with TV, radio, music and other audio circuits.

e. The dimmer shall fit into a single gage wall box and gang in standard wall boxes without breaking off fin sections or derating the dimmer load capacity.

f. Faceplates for dimmers shall match other coverplates in same area.

g. Dimmers shall be completely self-contained requiring no separate controls or other accessories and shall operate at full capacity in an ambient temperature up to 40 degree C.

Dimming Ballasts

a. All dimming ballasts shall be UL listed as Class P and provide resetting internal protection.

b. All dimming ballasts shall have been extended component recognition (yellow card) by UL for use with specified dimming controls.

c. External fuses shall not be used with 277V dimming ballasts.

d. It shall be the contractors responsibility to coordinate the dimming ballast requirements at each location requiring dimming.

e. Dimming ballasts shall be the electronic type approved for operation with fixture lamp type.

f. Dimming ballasts shall have a power factor greater then 90% throughout the dimming range.

g. Dimming ballasts shall have a total harmonic distortion content less than 10% at full light output.

h. Dimming ballasts shall have a lamp current crest factor of less than 1.6 throughout the dimming range.

i. Dimming blasts shall have a dimming range of 100-10%.

j. Electronic ballasts for T-8 lamps shall be the controllable, integrated circuit type. Control shall be 0-10 VDC with the 10VDC source supplied by the ballast.

2.10 High-Intensity-Discharge

a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1572.

b. Ballasts: ANSI C82.4 for multiple supply types and UL 1029.

2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral kilowatt, 373.0 kW 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.

2.13.1 Rating

The kilowatt 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.

2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 746 W or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. 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 Motor Efficiencies

kW	Std. Efficiency	High Efficiency
0.746	77.0	85.5
1.12	78.5	85.5
1.49	78.5	85.5
2.24	78.5	88.5
3.73	82.5	88.5
5.60	84.0	90.0
7.46	85.5	90.0
11.2	85.5	91.0
14.9	87.5	92.0
18.7	88.5	92.0
22.4	88.5	92.0
29.8	88.5	92.0
37.3	89.0	92.5
44.8	89.0	92.5
56.9	89.0	95.5
74.6	90.0	93.5
93.3	91.0	94.5
112	91.0	94.5
149	91.0	94.5
187	91.0	94.5
224	91.0	94.5
261	91.0	94.5
298	91.0	94.5
373	91.0	94.5

2.14 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.14.1 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.

2.14.2 Motor Starters

Combination starters shall be provided with circuit breakers.

2.14.2.1 Variable Frequency Drive Controllers

2.14.2.1.1 General

An ac adjustable frequency controller shall be supplied to control the speed of squirrel cage induction motors connected to a variable torque load where indicated. The controller shall include the following minimum functions, features and ratings.

2.15

An input (circuit breaker or fusible disconnect switch) shall be supplied to provide the NEC required safety disconnecting means and branch circuit protection, one each for the Variable Frequency Drive and one for the

bypass and isolation. The (breakers or switches) shall have an external operator.

2.16
Current limiting fuses shall be installed in the controller input.

2.17
A rectifier stage shall change fixed voltage fixed frequency ac line power to a fixed dc voltage. The rectifier shall consist of six power diodes in a three phase full wave bridge, configuration. The rectifier shall be insensitive to the phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

2.18
An inverter 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 utilize gate turn off (GTO) devices switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.

2.19
The controller shall be rated to operate in an ambient temperature 0-C to 40 C continuously. Installation at altitudes less than 3,300 feet above sea level shall not require derating.

2.20
The controller shall be capable of supplying 120% of rated full load current for one minute at maximum ambient temperature.

2.21
The controller shall be designed to operate from [460V] +10%, - 5% three phase, 60 Hertz supply and control a motor with a corresponding voltage rating.

2.22
A Hand Off-Automatic selector switch and manual speed potentiometer shall be provided for operator control functions. The controller shall accept an input signal of 0-10V dc or 4-20ma dc as an automatic speed reference signal when the controller is in the automatic mode of operation.

2.23
A bypass and isolation selector switch shall be provided to permit full speed (60HZ) operation of the motor if the controller is out of service. It shall include an isolation contactor to disconnect the controller from the motor, a full voltage non-reversing combination starter with overload relay to operate the motor across the line and a VFD-OFF-BYPASS selector switch.

2.24
Acceleration and deceleration time shall be independently adjustable from 6 seconds to 60 seconds.

2.25
The option to select between a controlled deceleration to stop or an uncontrolled coast to stop shall be available. The uncontrolled stop shall be available to prevent overvoltage trips on a decelerating load regenerating a large amount of power back to the controller.

2.26

Controller shall be factory set for constant V/Hz operation. However a reduced V/Hz mode of operation shall be available for those variable torque applications which require reduced motor noise.

2.27
Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120% Of the controller rated current.

2.28
The controller shall be capable of producing an output frequency over the range of 3 to 60 Hertz (20 to 1 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% of the maximum controller output frequency.

2.29
Minimum and maximum output frequency shall be adjustable over the following ranges:

Minimum frequency 3 Hertz to 54 Hertz.
Maximum frequency 40 Hertz to 60 Hertz

2.30

Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controller to any of the following conditions shall not result in component failure or the need for fuse replacement:

a. Short circuit at controller output
b. Ground fault at controller output
c. Open circuit at controller output
d. Input undervoltage
e. DC bus overvoltage
f. Loss of input phase
g. AC line switching transients
h. Instantaneous overload
i. Sustained overload exceeding 100% of controller rated current
j. Overtemperature

2.31
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. The timing circuit shall include a memory such that current exceeding the threshold for less than 60 seconds and dropping back below the threshold momentarily shall not cause the timer to reset to zero but shall cause the timing circuit to pick up at a point dependent upon the length of tho time the current was below the threshold.

2.32
The controller electronics shall contain light emitting diodes (LEDs) to monitor and indicate the following conditions:

Undervoltage	Overload Shutdown
Overvoltage	Power Up Delay
Overtemperature	Controller Enabled
Instantaneous Overcurrent	Current Limiting Operating (Motor Mode)
Ground Fault	Gate Driver Cards Operating (6)

Shoot Through Bus Power Undervoltage
Overload Threshold Exceeded

2.33
The controller shall include external fault reset capability. All logic necessary to accept an external fault reset contact shall be included. The controller shall be equipped with two-fault lockout capability.

The controller shall use a diode bridge input stage which does not produce the electrical switching transients common to converters using silicon controlled rectifiers, SCR's. In addition, the controller shall have a fault withstand capability of 65 KAIC RMS symmetrical amperes for 1 HP through 50HP variable torque. The use of an isolation transformer ahead of the controller shall not be necessary.

2.34 Thermal-Overload Protection

Each motor of 93 W (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.

2.35 Low-Voltage Motor Overload Relays

2.35.1 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 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.

2.35.2 Construction

Manual reset type thermal relay shall be melting alloy 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.

2.35.3 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 10 degrees C, an ambient temperature-compensated overload relay shall be provided.

2.36 Automatic Control Devices

2.36.1 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 kilowatt rating.

2.36.2 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.

2.36.3 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.

2.38 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.39 RECEPTACLES

2.39.2 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles. Isolated ground receptacles shall have an orange colored body.

2.39.4 Ground Fault Interrupters

UL 943, Class A or B.

2.39.6 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt

15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R, 20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

c. 20-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-20R, locking: NEMA type L6-20R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-20R, locking: NEMA type L15-20R.

2.40 Service Entrance Equipment

UL 869A.

2.41 SPLICE, CONDUCTOR

UL 486C.

2.42 POWER-SWITCHGEAR ASSEMBLIES INCLUDING SWITCHBOARDS

Assemblies shall be metal-enclosed, freestanding general-purpose type in accordance with NEMA PB 2, UL 891, and IEEE C37.20.1 and shall be installed to provide front and rear access. Busses shall be copper or aluminum. Assembly shall be approximately 2.3 meters high; arrangement of circuit breakers and other items specified shall be as indicated. The withstand rating and interrupting capacity of the switchboards and circuit breakers shall be based on the maximum fault current available.

2.42.1 Circuit Breakers

Circuit breakers shall be molded-case circuit breakers.

2.42.2 Auxiliary Equipment

2.42.2.1 Digital Power Monitor (PM)

Digital power monitor shall meet the accuracy as specified in ANSI C12.1 and ANSI C12.16. Digital power monitor shall be a microprocessor based monitoring and protective device that provides complete electrical metering values such as frequency, temperature, current, voltage, power factor, watts, vars, watt demand and watt hours. The PM shall also be capable of capturing current and voltage waveforms which may be exported to a personal computer where waveform or other power quality analysis may be performed. The PM shall incorporate electronic pulse initiation. The PM shall be UL listed and shall pass the ANSI/IEEE C37.90A surge withstand and fast transient tests.

2.43 SNAP SWITCHES

UL 20.

Occupancy Sensors

a. Ceiling mounted, ultra-sonic operation, delay-off adjustment, and ambient light override. Unit shall operate from low voltage (12VDC) with separate low voltage control unit. Unit shall have expansion capability with add-on relay control units. Contacts shall be rated for 120/277 volts.

2.44 TAPES

2.44.1 Plastic Tape

UL 510.

2.44.2 Rubber Tape

UL 510.

2.45 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.

2.45.1 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 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 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 . Provide transformers in NEMA 1 enclosure.

2.45.3 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 300 mm for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

2.50 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

2.32 Elapsed Time Indicator

The elapsed time indicator shall contain 6-2" digits, displaying hours, minutes, and seconds up to 23:59:59. Unit shall be ceiling mounted in a metal

enclosure with black enamel finish. Timer shall operate on 120VAC, 60Hz circuit.
A start-stop-reset switch shall be located on the wall directly below timer at a height convenient for accessibility. Switch faceplate shall be engraved to indicate start-stop-reset functions.

2.52 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.

2.52.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: outgoing medium voltage feeders, through the secondary side of transformers.

2.52.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented.

2.52.3 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.

2.52.4 Fault Current Analysis

2.52.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE Std 242, and IEEE Std 399.

2.52.4.2 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.

2.52.4.3 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.

2.52.5 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.

2.52.6 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.

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 25 ohms under normally dry conditions. If this resistance

cannot be obtained with a single rod, two additional rods not less than 1.8 meters on centers, or if sectional type rods are used, two additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 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 as indicated. Noncurrent-carrying metal parts of transformer neutrals and other 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. 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.

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, electrical metallic tubing, [and 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.

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 16 mm. 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. 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. Nonaluminum sleeves shall be used where aluminum conduit passes through concrete floors and firewalls. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07270 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 150 mm 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. Wiring installed in underfloor duct system shall be suitable for installation in wet locations.

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 15 meters in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 45 meters in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 1.4 MPa (200 psi) tensile strength. Not less than 254 mm 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 150 mm 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 0.254 mm thick pipe-wrapping plastic tape applied with a 50 percent overlay, 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 25.4 mm 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. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.6 Supports

Except where otherwise permitted by NFPA 70, conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 3 meters and within 900 mm 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 will 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.

3.2.1.10 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 15 meters for 15 mm and 20 mm sizes, and 30 meters for 25 mm or larger sizes, and shall not contain more than two 90-degrees 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 25 mm (1 inch) size or larger shall not be less than ten times the nominal diameter. .

3.2.3 Cable Trays

Cable trays shall be supported in accordance with the recommendations of the manufacturer but at no more than 1.8 meter intervals. 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 250 mm from both sides of smoke and fire partitions. Conductors run through smoke and fire partitions shall be installed in 103 mm (4 inch) rigid steel conduits with grounding bushings, extending 300 mm 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 07270 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 30 meters long and of 277 volts more than 70 meters 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

Unless otherwise indicated, the Contractor may substitute aluminum conductors in lieu of copper conductors for copper sizes No. 4 AWG and larger. Should the Contractor choose to provide aluminum for conductors, the Contractor shall be responsible for increasing conductor size to have same ampacity as copper size indicated; increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductors is sufficient; providing panelboards that are UL listed for use with

aluminum, and so labelled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are a direct result of providing aluminum conductors in lieu of copper.

3.2.4.3 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 three-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).
120/240-volt, 1-phase: Black and red.

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 75 mm 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 1.2 meters above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 600 mm. The total combined area of all box openings in fire rated walls shall not exceed 0.0645 square meters per 9.3 square meters. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and must not exceed the maximum specified for that box in UL-03. Only boxes listed

in UL-03 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, 102 by 102 mm nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Cast-metal 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 102 mm square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 2.4 mm wall thickness are acceptable. Large size boxes shall be NEMA 1 or as shown. Boxes in other locations shall be sheet steel. 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 38.1 mm (1-1/2 inches) into reinforced-concrete beams or more than 19.1 mm (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 25 mm 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 300 mm 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 6 mm 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 600 mm 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 of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be impact-resistant plastic and shall be ivory. 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 1.6 mm. 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, 15 or 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 ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, 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.

3.5.4 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.

3.5.4.1 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.

3.5.4.2 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.

3.5.6 Receptacles, 20-Ampere, 250-Volt

Receptacles, single, 20-ampere, 250-volt, shall be ivory molded plastic, two-pole, three-wire grounding type complete with appropriate mating cord-grip plug.

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-ampere277 -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 enclosed molded-case circuit breaker type 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.

3.8.2 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 1.5 m beyond the building wall and 600 mm 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 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

3.12 MOTORS

Each motor shall conform to the kW 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 kilowatt (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.

3.13 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 93 W (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 kilowatt 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.

3.13.1 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.

3.13.2 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.

3.14 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.

3.15 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 1.5 meters 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.

3.16 LAMPS AND LIGHTING FIXTURES

Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

3.16.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

3.16.1.1 Incandescent

Incandescent lamps shall be for 125-volt operation unless otherwise indicated.

3.16.1.2 Fluorescent

Fluorescent lamps for magnetic ballasts shall be as indicated and shall be of a type that will not require starter switches. Lamps shall be of the rapid-start type unless otherwise shown or approved. Fluorescent lamps for electronic ballasts shall be as indicated.

3.16.1.3 High-Intensity-Discharge

High-intensity-discharge lamps shall be the high-pressure sodium type unless otherwise indicated, shown, or approved.

3.16.2 Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on Standard Drawing No. 40-06-04, Sheet Nos. 16, 17, 30, 33, 36, 39, and 40, which accompany and form a part of this specification for the types indicated. Illustrations shown on these sheets 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.

3.16.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent fixtures with exposed lamps shall have a wire-basket type guard.

3.16.2.2 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers in order to ensure a plumb installation. Pendants, rods, or chains 1.2 meters or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional, 120 degrees apart. Single unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 3.1 meters.

Rods shall be of not less than 4.8 mm (3/16 inch) diameter. Flexible raceway shall be installed to each fixture from an overhead junction box. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

3.16.2.3 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on, or from the suspended ceiling provided under other sections of these specifications. Installation and support of fixtures shall be in accordance with the NFPA 70 and manufacturer's recommendations. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended 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 panels, in conformance with UL-03. Surface-mounted fixtures shall be suitable for fastening to the structural support for

ceiling panels.

3.16.2.4 Sockets

Sockets of industrial, strip, and other open type fluorescent fixtures shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

3.16.3 EQUIPMENT CONNECTIONS

All 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 2 m 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.

3.16.3.1 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.

3.16.4 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.

3.16.5 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.16.6 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.16.7 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 30 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.

3.16.7.1 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.

3.16.7.2 Ground-Resistance Tests

The resistance of each grounding electrode system 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: 25 ohms .

b. Grid electrode: 25 ohms.

3.16.7.3 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 24 hours before the site is ready for inspection.

3.16.7.4 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 304,800/(length of cable in meters)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.16.7.4.1 Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3.18 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 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.

3.21 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.21.3 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.

3.24 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.

3.25 FIELD SERVICE

3.25.1 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, 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.

3.25.2 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.

3.26 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.

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SECTION 16528

EXTERIOR LIGHTING

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-2	(1985; Rev 1986, 1987, 1988) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(1997) National Electrical Safety Code
ANSI C78.1	(1991; C78.1a) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.40	(1992) Mercury Lamps
ANSI C78.1350	(1990) 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C78.1375	(1990) 400-Watt, M59 Single-Ended Metal-Halide Lamps
ANSI C78.1376	(1990) 1000-Watt, M47 Single-Ended Metal-Halide Lamps
ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C119.1	(1986) Sealed Insulated Underground

	Connector Systems Rated 600 Volts
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C135.30	(1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
ANSI C136.2	(1985) Luminaires Voltage Classification
ANSI C136.3	(1989) Luminaire Attachments - for Roadway Lighting Equipment
ANSI C136.6	(1990) Roadway Lighting Equipment - Metal Heads and Reflector Assemblies - Mechanical and Optical Interchangeability
ANSI C136.9	(1990) Roadway Lighting Equipment - Socket Support Assemblies for Metal Heads - Mechanical Interchangeability
ANSI C136.10	(1988) Locking-type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing for Roadway Lighting Equipment
ANSI C136.11	(1988) Multiple Sockets for Roadway Lighting Equipment
ANSI C136.13	(1992) Metal Brackets for Wood Poles
ANSI C136.15	(1986) High-Intensity-Discharge and Low-Pressure Sodium Lamps in Luminaires - Field Identification
ANSI C136.20	(1990) Roadway Lighting Equipment - Fiber Reinforced Lighting Poles (FRP)
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1982; R 1987) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 575	(1989) Steel Bars, Carbon, Merchant Quality, M-Grades

ASTM A 576	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 2	(1988) Medium-Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 478	(1993) Precast Reinforced Concrete Manhole Sections
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C4	(1993) Poles - Preservative Treatment by Pressure Processes
AWPA C25	(1992) Sawn Crossarms - Preservative Treatment by Pressure Processes
AWPA P1/P13	(1991) Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water) Use
AWPA P8	(1991) Standard for Oil-Borne Preservatives
AWPA P9	(1992) Standard for Solvents and Formulations for Organic Preservative Systems

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 232-E	(1991) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA ARP-8	(1983) Roadway Lighting

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment

	(1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems
NEMA ICS 2	(1993) Industrial Control Devices, Controllers and Assemblies
NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems
NEMA OS 1	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
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	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993) Rigid Metal Conduit
UL 44	(1991; Rev thru Jan 1995) Rubber-Insulated Wires and Cables
UL 98	(1994; Rev Feb 1995) Enclosed and Dead-Front Switches
UL 467	(1993) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1991; Rev thru Apr 1992) Wire Connections for Use with Aluminum Conductors
UL 506	(1994; Rev Jul 1994) Specialty Transformers
UL 514A	(1991) Metallic Outlet Boxes
UL 514B	(1992; Rev thru Apr 1995) Fittings for Conduit and Outlet Boxes
UL 514C	(1988; Rev Apr 1995) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL 651	(1989; Rev thru Dec 1989) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1989; Rev thru Dec 1989) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 854	(1991; Rev thru Apr 1993) Service-Entrance Cables
UL 886	(1994; Rev thru Jul 1995) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 870	(1991) Wireways, Auxiliary Gutters, and Associated Fittings
UL 1029	(1994) High-Intensity-Discharge Lamp Ballasts
UL 1449	(1985; Errata Apr 1986) Transient Voltage Surge Suppressors
UL 1571	(1991; Rev thru Jul 1994) Incandescent Lighting Fixtures
UL 1572	(1991; Rev thru Jul 1994) High Intensity Discharge Lighting Fixtures

1.2 SYSTEM DESCRIPTION

1.2.1 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.

1.2.3 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.

1.2.4 Interface Between Lighting System and Power Distribution

Conductors shall shall be as indicated.

1.2.5 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.

1.2.6 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.

1.2.7 Unusual Service Conditions

Equipment and materials furnished under this section shall be suitable for the following unusual service conditions: Salt air.

1.2.9 Protection of Lighting System Components

1.2.9.1 Components and Conductors

Lighting system conductors shall be protected from damage. Lighting system conductors shall be installed in raceways . Where the conductors leave the underground systems, the conductors shall be in rigid steel conduit of the indicated size.

1.3 CORROSION PROTECTION

1.3.1 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.

1.3.2 Ferrous Metal Materials

1.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

1.3.2.2 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 120 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 1.6 mm (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.

1.3.3 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 PAINTING, GENERAL.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Materials; FIO.

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; FIO.

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-04 Drawings

Lighting System; GA.

Detail drawings for the complete system and for poles, lighting fixtures, and handholes.

As-Built Drawings; FIO.

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

SD-09 Reports

Operating Test; FIO.

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; FIO.

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-19 Operation and Maintenance Manuals

Lighting System; FIO.

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.

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.

2.3 CABLE

The Contractor shall provide all wire and cable. 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 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.

2.3.3 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.

2.3.6 CONDUIT, DUCTS AND FITTINGS

2.3.6.1 Conduit, Rigid Steel

Rigid steel conduit shall conform to ANSI C80.1 and UL 6.

2.8.2 UL 651 Schedule 80, or NEMA TC 6 Type DB.

2.3.6.3 Conduit Fittings and Outlets

2.3.6.3.1 Boxes, Metallic Outlets

NEMA OS 1 and UL 514A.

2.4 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

2.7 Fittings for Conduit and Outlet Boxes

UL 514B.

2.9 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.10 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 75 degree C (167 degrees 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."

2.12 GROUND RODS

Ground rods shall be of copper clad steel conforming to UL 467 not less than 19.1 mm (3/4 inch) in diameter by 3.1 m (10 feet) in length of the sectional type driven full length into earth.

2.13 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 40.2 meters per second (90 mph) at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-2. 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 . Scratched, stained, chipped, or dented poles shall not be installed.

2.13.1 Aluminum Poles

Aluminum poles and brackets for parking lot 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 square and of seamless construction. The wall thickness shall be at least 4.8 mm (0.188 in). 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. 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.

2.13.3 Anchor Bolts

Anchor bolts shall be the pole manufacturer's standard, but not less than necessary to meet the pole wind loading, herein and other specified design requirements.

2.14 ELECTRICAL ENCLOSURES

The Contractor shall provide metallic enclosures as needed to house the lighting control equipment. Enclosures shall conform to NEMA ICS 6 and NEMA 250. Enclosures shall be provided with lockable or padlock handles. Keys for lockable enclosures shall be delivered to the Contracting Officer.

2.14.1 Interior Enclosures

Enclosures to house lighting equipment in an interior environment shall meet the requirements of a NEMA 12 enclosure as defined in NEMA 250.

2.15 ILLUMINATION

2.15.1 General Lighting

Luminaires, ballasts, lamps, and control devices required for general area lighting shall be in accordance with sheet 51 of Standard Detail No. 40-06-04, attached to these specifications, and as detailed on the drawings.

2.16 LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

2.16.1 High-Pressure Sodium

Lamps shall conform to ANSI C78.1355. Ballasts shall conform to ANSI C82.4, or UL 1029. High-pressure sodium lamps shall be clear.

2.17 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.

2.18 LIGHTING CONTROL EQUIPMENT

2.18.1 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 5.4 to 53.8 lux.

2.18.2 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 277 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 1 (indoor) enclosure conforming to NEMA ICS 6.

2.18.3 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 277] volts, single phase, 60 Hz. Coil voltage shall be 277 volts. 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 1. Each contactor shall be provided with a spare, normally open auxiliary contact. Terminal lugs shall be coordinated with the wire size.

2.19 PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to IESNA ARP-8.

2.21 FIXTURES

Standard fixtures shall be as detailed on Standard Detail No. 40-06-04, Sheet Nos. 51 which accompany and form a part of this specification. Special fixtures shall be as indicated on the drawings. Illustrations shown on these sheets 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.

2.21.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

2.22 3 EXECUTION

3.1 GENERAL

The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions, ANSI 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.

3.3 INSTALLATION

3.3.1 See Electrical Distribution System, Underground, Section 16375, for installation requirements for conduit, ducts, and wiring.

3.3.5 POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height of 7.5 m (25 feet). Luminaire mounting height may be increased by the height of the transformer base where required. Electrical cabling shall be provided to the light pole as specified in Section 16375, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Pole installation shall conform to the manufacturer's recommendations, NFPA 70, and ANSI C2. Poles shall be set straight and plumb.

3.3.5.2 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 and grout work shall conform to Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Concrete shall be 21 MPa (3000 psi) at 28 days.

3.3.5.3 Aluminum Pole Installation

Poles shall be mounted on cast-in-place foundations. Conduit elbows shall be provided for cable entrances into pole interiors.

3.3.5.3.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. 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 manufactures standard, and not less than necessary to meet the pole wind loading and other specified design requirements.

3.5 LIGHTING

3.5.1 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.

3.5.2 Fixture Installation

Standard fixtures shall be installed as detailed on Standard Detail No. 04-06-04, Sheet Nos. 51, which accompany and form a part of this specification. Special fixtures shall be as indicated on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality will be acceptable as approved.

3.5.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be installed as required for proper installation.

3.7 LIGHTING CONTROL SYSTEM

3.7.1 Photo-Control

Lighting luminaires shall be controlled by a single photo-control element and time clock controlled lighting contactor .

3.7.2 Time Control Switch

Switch shall be located in the building electrical room.

3.7.4 Magnetic Contactor

Magnetic contactor shall be located in control panel with time clock.

3.8 GROUNDING

3.12.1 See Electrical Distribution Distribution System, Underground, Section 16375, for grounding requirements.

3.9 TESTS

3.9.2 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.

3.9.3 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 --

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DIVISION 16 - ELECTRICAL

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SECTION 16610

UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM ABOVE 15 KVA CAPACITY

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 173	(1990) Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, For Electrical Conductors

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.110	(1986; R 1993) Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents
IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 450	(1995) Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
IEEE Std 485	(1983) Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-099S94	(1994) Uniform Building Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

NEMA PE 1	(1992) Uninterruptible Power Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

1.2 SYSTEM DESCRIPTION

The UPS system shall consist of UPS module, battery system, battery protective device, system cabinet, static bypass transfer 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.

1.2.1 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.

1.2.2 Cabinet, Static Bypass Transfer Switch, 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.

1.2.3 Design Requirements

1.2.3.1 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.

1.2.3.2 Components

Active electronic devices shall be solid state. Semiconductor devices shall be sealed. Relays shall be dust-tight.

1.2.3.3 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.

1.2.3.4 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.

1.2.3.5 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.

1.2.3.6 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.

1.2.3.7 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.

1.2.3.8 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.

1.2.3.9 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.

1.2.3.10 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.

1.2.3.11 Cabinet Finish

Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards.

1.2.3.12 Mimic Bus

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.

1.2.3.13 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.

1.2.3.14 Drawout Assemblies

Drawout assemblies weighing 23 kg (50 lbs) or more shall be provided with a means of lifting, either an overhead device or a hoisting device.

1.2.3.15 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.

1.2.4 Performance Requirements

1.2.4.1 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.

1.2.4.2 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.

1.2.4.3 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.

1.2.4.4 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.

1.2.4.6 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.

1.2.4.7 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.

1.2.4.9 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.

1.2.4.10 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.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

UPS System Performance Data Sheets; GA.

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; FIO.

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.

Lesson Plans and Training Manuals; GA.

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-04 Drawings

UPS System; GA.

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-09 Reports

Factory and Field Tests; GA.

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 two 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.

1.4 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 1,200 meters (4,000 ft.) (Systems applied at higher altitudes shall be derated in accordance with the manufacturer's instructions).

b. Non-operating altitude: Sea level to 12,000 meters (40,000 ft.)

c. Operating ambient temperature range: 0 to 50 degrees C.

d. Non-operating and storage ambient temperature range: Minus 20 to plus 60 degrees C.

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 1.5 meters in any direction from the perimeter of the unit, shall not exceed 75 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: Data Processing Equipment.

Size of load: 265kW Demand Load.

Switching pattern: Cycled Daily.

Transient characteristics: 5 times steady state RMS current for 1/4 cycle.

Steady-state characteristics: 0.9PF.

2.3 UPS SYSTEM RATINGS

Unless stated otherwise, the parameters listed are under full output load at 0.9 power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.

2.3.1 System Capacity

Overall 313 kVA, 250 kW, non redundant, at 50 degrees C.

2.3.2 Module Capacity

313 kVA, 250 kW.

2.3.3 Battery Capacity

Discharge time to end voltage: 15 minutes, at 25 degrees C. Battery shall be capable of delivering 125 percent of full rated UPS load at initial start-up.

2.3.4 Static Switch

400 amperes, 38,000 amperes symmetrical interrupting capacity.

2.3.5 System Bus Bracing

Braced for 38,000 amperes symmetrical 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: 5 percent maximum.

g. Transformer sub-cycle inrush: 4 to 8 times full load rating.

2.3.7 ac Output

a. Voltage 208 volts line-to-line, 120 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.

d. Loss or return of redundant module:

(1) Manually: Plus or minus 8 percent.

(2) Automatically: Plus or minus 8 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 38,000 amperes symmetrical interrupting capacity. 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.

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.

2.7 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.

2.9 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.

2.10 REMOTE MONITORING PANEL

A remote monitoring panel shall be provided to monitor system status. The panel shall be designed for flush wall mounting as indicated.

2.10.1 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).

2.10.2 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.

2.12 TEMPERATURE CONTROL

2.12.1 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.

2.12.2 Blower Power Source

Blower power source shall be internally derived from the input and output sides of UPS module, with automatic transfer arrangement.

2.12.3 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 30 minutes.

2.13 BATTERY SYSTEM

2.13.1 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.

2.13.2 Battery Ratings

a. Type: lead calcium.

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.

2.13.3 Battery Construction

The battery shall be of the valve-regulated, sealed, non-gassing, recombinant type.

2.13.5 Battery Rack

The battery shall be provided with a suitable number of two-tier racks to fit the room layout shown. Battery rack shall be steel and shall be protected with electrolyte-resistant paint. Battery rack shall be shipped unassembled and shall include hardware necessary for assembly. Each rack shall be complete with bus bars to accommodate cables from UPS module. Bus bar connectors for battery-to-battery connections and high-flex multi-stranded copper cable (ASTM B 173 stranding class H) with proper cable supports for connecting top row of batteries to bottom row of batteries at rack ends shall be provided. End sections shall be cut to length to prevent wasting floor space.

2.13.6 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.

2.13.7 Battery Disconnect

Each battery pack assembly shall have a shunt trip circuit breaker provided in a NEMA 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Circuit breaker shall be complete with line side and load side bus bars for connection to battery cells. Circuit breaker shall be rated 600 V dc, 1200 amperes, 2-pole with interrupting rating as required by system capacity, and shall have an external operator that is lockable in the "off" position.

2.13.8 Seismic Requirements

The battery support system shall conform to ICBO-099S94 requirements for seismic zone 4.

2.13.9 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.

2.14 FACTORY TESTING

2.14.1 General

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.

2.14.2 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.

2.14.3 Efficiency Tests

Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps,0.9 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.

2.15 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.

3.2 FIELD SUPERVISION, STARTUP AND TESTING

3.2.1 General

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.

3.2.2 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.

3.2.3 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).

b. Input current (all three phases).

c. Input frequency.

d. Battery voltage for each module.

e. Output voltage (all three phases).

f. Output current (all three phases).

g. Output kilowatts .

h. Output frequency.

i. Output voltage (all three phases - system output).

j. Output current (all three phases - system output).

k. Output kilowatts (system output).

3.2.4 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 on and off a minimum of five times within the burn-in period.

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.

3.2.5 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.

b. Battery current.

c. Output voltage (all three phases).

d. Output current (all three phases).

e. Output kilowatts.

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	
	NUMBER OF SYSTEMS	1	
GENERAL	NUMBER OF MODULES IN EACH SYSTEM	PRESENT 3 FUTURE 0	
	SYSTEM CAPACITY: PRESENT FUTURE	 250 kW/313 kVA 0 kW/0 kVA	
	BATTERY	ONE PER MODULE	
	MTBF (SYSTEM)	20,000 hours	
	MTTR	30 minutes	
MODULE	DC VOLTAGE WINDOW	2.20 to 2.25 Vdc	
	INPUT/OUTPUT PROTECTIVE DEVICE INTERRUPT. RATING	38,000 A SYM.	
BATTERY	MANUFACTURER		
	TYPE	LEAD-CALCIUM	
	DISCHARGE TIME TO END VOLTAGE AT FULL LOAD	15 MINUTES	
	END VOLTAGE	1.67 V/CELL	
	SPECIFIC GRAVITY	1.215	
	FLOAT VOLTAGE	2.17 to 2.26 V/CELL	
	NUMBER OF CELLS		

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 2 OF 6

	ITEM	SPECIFIED	SUBMITTED
BATT	HYDROGEN GENERATION	_____	
	RECHARGE TIME TO 95% CAPACITY	10 X DISCHARGE	
SYSTEM CABINET	PROTECTIVE DEVICE	AIR POWER, DRAW-OUT	
	MANUFACTURER	_____	
	INTERRUPTING RATE	38,000 A SYM.	
	STATIC SWITCH	400 A	
AC INPUT	VOLTS, LINE/LINE	480 V	
	PHASES	3-PHASE, 3-WIRE	
	VOLTAGE RANGE	+ 10%, - 15%	
	FREQUENCY	60 Hz	
	FREQUENCY RANGE	+/- 5%	
	POWER WALK-IN 20% TO 100% LOAD	15 - 24 SECONDS	
	TOTAL HARMONIC DISTORTION REFLECTED-PRIMARY	5% MAX (CURRENT)	
	ORDER OF HARMONIC	_____	PERCENTAGE OF TOTAL
	2nd		
	3rd		
	4th		
	5th		
	6th		
	7th		
	8th		
	9th		
(FILL IN AS REQUIRED)			
	TRANSFORMER SUB-CYCLE INRUSH	4 to 8 x FULL LOAD	
	POWER FACTOR	0.9	

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 3 OF 6

	ITEM	SPECIFIED	SUBMITTED
	VOLTAGE, LINE-LINE	208 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	FREQUENCY	60 Hz	
C	REGULATION	+/- 0.1%	
O	DRIFT (24 HRS.)	+/- 0.1%	
U	HARMONIC CONTENT		
T	TOTAL (50% NON-LINEAR LOAD	7.0% MAX.	
P	TOTAL (LINEAR LOAD)	5.0% MAX.	
U	SINGLE HARMONIC (LINEAR LOAD)	3.0% MAX.	
T	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 TRANSFER, AT FULL LOAD, FROM BYPASS TO UPS	+/- 4.0%	
	RECOVERY TIME TO 99% STEADY-STATE COND.	50 MILLISECONDS	
	FREQUENCY TRANSIENT RESPONSE	+/- 0.5 Hz	
	SLEW RATE	1.0 Hz/SECOND	

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 5 OF 6

	ITEM	SPECIFIED	SUBMITTED
AC OUTPUT	EFFICIENCY @ FULL LOAD		
	MODULE	90%	
	SYSTEM	89%	
	SYSTEM NOISE GEN. LEVEL @ 1.8 M		
	FROM EQUIPMENT	75 DBA	
	OPERATING AMBIENT TEMPERATURE	0 DEG. C to 50 DEG. C	
	STORAGE AMBIENT TEMPERATURE	-20 DEG. C to +60 DEG. C	
ENVIRONMENTAL	BATTERY ROOM AMBIENT TEMP.	25 DEG. C NOMINAL	
	RELATIVE HUMIDITY (NON-CONDENSING)	0 - 95%	
	BAROMETRIC PRESSURE (ALTITUDE)		
	OPERATING		
	NON-OPERATING	12,200 M	
	HEAT REJECTION	_____	
	MODULE		
	SYSTEM		
PHYSICAL DATA	MODULE	_____	
	SIZE		
	WEIGHT		
	SYSTEM CABINET	_____	
	SIZE		
	WEIGHT		

UPS SYSTEM PERFORMANCE DATA SHEET SHEET 6 OF 6

	ITEM	SPECIFIED	SUBMITTED
PHYSICAL DATA	BATTERY	_____	
	SEISMIC ZONE		
	RACKS SIZE		
	WEIGHT		
	CELLS SIZE		
	WEIGHT		
	DISCON- SIZE		
	NECT WEIGHT		

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SECTION 16640

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SECTION 16640

CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)

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 418	(1988) Cast and Wrought Galvanic Zinc Anodes

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE RP0169	(1992) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1981; Rev thru Dec, 1992) Rigid Metal Conduit
UL 510	(1986; Rev Oct 1986) Insulating Tape
UL 514A	(1991) Metallic Outlet Boxes

1.2 GENERAL REQUIREMENTS

1.2.1 Services of Corrosion Engineer

If the Contractor chooses the metallic option for buried piping, he shall obtain the services of a corrosion engineer to design, supervise and to inspect the installation of the cathodic protection system. Corrosion Engineer refers to a person, who, by reason of his knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control on buried or submerged metallic piping systems and metallic tanks. Such person may be a licensed professional engineer or may be a person certified as being qualified by the National Association`of Corrosion Engineers if such licensing or certification includes suitable experience in corrosion control on buried or submerged metallic piping systems and metallic tanks.

The corrosion engineer shall insure that the cathodic protection system is installed, tested, and placed into service in accordance with the requirements specified.

1.2.2 Rules

The design shall conform to MIL-HDBK-1004/10, AFI 32-1054, and NACE Standards.
The installation shall conform to NACE Standards, and the applicable rules of NFPA 70.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. All submittal information shall be coordinated with the Base Corrosion Engineer. A copy of all as-built drawings and reports shall be submitted to the Base Corrosion Engineer.The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Cathodic Protection System; FIO.

Manufacturer's Catalog Data.

Qualifications; FIO.

Evidence of qualifications of the corrosion engineer.

SD-04 Drawings

Cathodic Protection System; FIO.

Detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit.

SD-09 Reports

Tests and Measurements; FIO.

Test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system.

PART 2 PRODUCTS

2.1 ANODES

2.1.1 Magnesium Anodes

Magnesium anodes shall be Type I, Type II (D,E), Type III or magnesium-manganese corresponding to the applicable chemical composition listed in the following table:

PERCENT BY WEIGHT

ELEMENT	TYPE I	TYPE II	TYPE III	MG-MN ALLOY
Aluminum	5.0 - 7.0	5.3 - 6.7	5.3 - 6.7	0.010 Max.
Zinc	2.0 - 4.0	2.5 - 3.5	2.5 - 3.5	
Manganese	0.15 Min.	0.15 Min.	0.15 Min.	0.50 - 1.30
Copper	0.1 Max.	0.05 Max.	0.02 Max.	0.02 Max.
Silicon	0.30 Max.	0.30 Max.	0.10 Max.	
Iron	0.003 Max.	0.003 Max.	0.003 Max.	0.03 Max.
Nickel	0.003 Max.	0.003 Max.	0.002 Max.	0.001 Max.
Others	0.30 Max.	0.30 Max.	0.30 Max.	0.05 each or 0.30 Max. Total
Magnesium	Balance	Balance	Balance	Balance

2.1.2 Zinc Anodes

Zinc anodes shall conform to ASTM B 418, Type II.

2.1.3 Connecting Wire

Wire shall be No. 12 AWG solid copper wire, not less than 3 m long, unspliced, complying with NFPA 70, Type TW or RHH insulation. Connecting wires for magnesium anodes shall be factory installed with the place of emergence from the anode in a cavity sealed flush with a dielectric sealing compound. Connecting wires for zinc anodes shall be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.

2.1.4 Artificial Backfill

Anodes shall be factory packaged with an artificial backfill in a water permeable fabric sack or cardboard container. Anodes shall be packaged on a vibrating platform to attain dense packing, and centering shall be assured by means of spacers.

Artificial backfill shall have the following composition:

Material	Approximate Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5
Total	100

2.2 MISCELLANEOUS MATERIALS

2.2.1 Electrical Wire

Wire shall be stranded copper wire sized in accordance with NFPA 70, Type TW, RHW-USE or RHW-USE insulation. Connecting wire splicing shall be copper compression connections made for the purpose or exothermic welds following instructions of the manufacturer. Split-bolt connections shall not be used.

2.2.2 Conduit

Rigid galvanized steel conduit and accessories shall conform to UL 6. Non

metallic conduit shall conform to NEMA TC 2.

2.2.3 Test Boxes and Junctions Boxes

Boxes shall be outdoor type conforming to UL 514A.

2.2.4 Joint, Patch, Seal, and Repair Coating

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 12.7 mm thick.

Coating compound shall be cold-applied coal-tar base mastic, hot-applied coal-tar enamel or an approved pipeline wrapping.

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.5 Preformed Sheaths

Sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joint.

2.2.6 Epoxy Potting Compound

Compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.2.7 Test Stations

Test stations shall be complete with an insulated terminal block having the indicated number of terminals and shall be provided with a lockable cover and have a cast-in legend, "C.P. Test".

PART 3 EXECUTION

3.1 INSTALLATION

Unless otherwise indicated, all equipment shall be installed in accordance with the manufacturer's recommendations. Where equipment is indicated to be provided "as required", this shall mean equipment is provided as designed, supervised and inspected by the corrosion engineer.

3.1.1 Anode Installation

Anodes of the size required shall be installed at the required locations. Locations may be changed to clear obstructions if approved. Anodes shall be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire shall not be used for lowering the anode into the hole. The annular space around the anode shall be backfilled with fine earth in 150 mm layers and each layer shall be hand tamped. Care must be exercised not to strike the anode or connecting wire with the tamper. Approximately 20 liters of water shall be applied to each filled hole after anode backfilling and tamping has been completed to a point about 150 mm above the anode. After the water has been absorbed by the earth, backfilling shall be completed to the ground surface level.

Single anodes spaced as required shall be direct connected or connected through a test station to the pipeline (as required), allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

Groups of anodes in quantity and location required shall be connected to a collector cable. The collector cable shall make contact with the structure to be protected only through a test station.

Resistance wires shall not be used to reduce the current output of individual or group anodes.

Connections to ferrous pipe shall be made by exothermic weld methods manufactured for the type of pipe.

3.1.2 Test Stations

Test stations shall be as required and shall be curb box, post or indoor mounted. Buried electrically insulating joints shall be provided with test wire connections brought to a test station. Unless otherwise shown, other test stations shall be located as follows:

a. At 300 m intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both sides of an insulating joint are not accessible above ground for testing purposes.

3.2 CRITERIA OF PROTECTION

Criteria for determining the adequacy of protection on a buried pipe shall be in accordance with NACE RP0169 and shall be selected by the corrosion engineer as applicable.

3.2.1 Iron and Steel

One of the following methods shall apply:

3.2.1.1 850 MV Negative Voltage

A negative voltage of at least minus 0.85 volt as measured between the pipe and a saturated copper-copper sulfate reference electrode contacting the earth directly over the pipe. Determination of this voltage shall be made with the cathodic system in operation.

3.2.1.2 300 MV Negative Voltage

A negative voltage shift of at least 300 millivolts as measured between the pipe and a saturated copper-copper sulfate reference electrode contacting the earth directly over the pipe. Determination of this voltage shift shall be made with the protective current applied. These criteria apply to pipes not in electrical contact with dissimilar metals.

3.2.1.3 100 MV Polarization Voltage

A minimum polarization voltage shift of 100 millivolts as measured between

the pipe and a saturated copper-copper sulfate reference electrode contacting the earth directly over the pipe. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay.

3.2.2 Aluminum

Aluminum pipes shall under no circumstances be protected to a potential more negative than minus 1.20 volts, measured between the pipe and a saturated copper-copper sulfate reference electrode contacting the earth, directly over the pipe. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum pipe to a value which will not exceed a potential more negative than minus 1.20 volts. Voltage shift criterion shall be one of the following:

3.2.2.1 150 MV Negative Voltage

A minimum negative voltage shift of 150 millivolts produced by the application of protective current. The voltage shift shall be measured between the pipe and a saturated copper-copper sulfate reference electrode contacting the earth directly over the pipe.

3.2.2.2 100 MV Negative Voltage

A minimum negative polarization voltage shift of 100 millivolts measured between the pipe and a saturated copper-copper sulfate reference electrode contacting the earth, directly over the pipe. The polarization voltage shift shall be determined as outlined for iron and steel.

3.3 TESTS AND MEASUREMENTS

3.3.1 Baseline Potentials

After backfill of the pipe and anodes is completed, but before the anodes are connected to the pipe, the static potential-to-soil of the pipe shall be measured. The locations of these measurements shall be identical to the locations specified for pipe-to-reference electrode potential measurements. The initial measurements shall be recorded.

3.3.2 Insulation Testing

Before the anode system is connected to the pipe, an insulation test shall be made at each insulating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two insulated sections of the pipe. Any insulating fittings installed and found to be defective shall be reported to the Contracting Officer.

3.3.3 Anode Output

As the anodes or groups of anodes are connected to the pipe, current output shall be measured with an approved low resistance ammeter. The values obtained and the date, time, and location shall be recorded.

3.3.4 Pipe-To-Reference Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulfate reference electrode and a potentiometer-voltmeter, or a direct current voltmeter having an internal resistance (sensitivity) of not less than 100,000 ohms per volt and a full scale of 1 or 2 volts. The locations of these measurements shall be identical to the locations used for the baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded.

3.3.5 Location of Measurements

3.3.5.1 Piping or Conduit

For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Measurements shall be made at intervals not exceeding 120 m. In no case shall less than three measurements be made over any length of line. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.3.6 Casing Tests

Casing tests before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.3.7 Interference Testing

Before final acceptance of the installation, interference tests shall be made with respect to any foreign pipes in cooperation with the owner of the foreign pipes. A full report of the tests giving all details shall be made.

3.3.8 Recording Measurements

All pipe-to-soil potential measurements including initial potentials where required shall be recorded. The Contractor shall locate, correct and report to the Contracting Officer any short circuits to foreign pipes encountered during checkout of the installed cathodic protection system. Pipe-to-soil potential measurements are required on as many pipes as necessary to determine the extent of protection or to locate short-circuits.

3.4 PIPE JOINTS

3.4.1 Electrical Continuity

Underground pipe shall be electrically continuous except at places where electrically insulating joints are specified. Pipe joined by means other than welding shall meet electrical continuity requirements. The following mechanical joints that are not factory designed to provide electrical continuity shall be bonded by installing a metallic bond across the joint. The bonding connections shall be made by the exothermic welding process. Mechanical joints designed to provide electrical continuity shall meet manufacturer's published standards.

3.4.2 Coating

Mechanical joints and fittings of either the electrically conductive or

insulating type shall be coated with an underground type dielectric coating system. Where external electrical continuity bonds are installed across mechanical joints, all bare or exposed metal, welds, bare wire and exposed coupling parts shall be coated with a coating system.

Couplings and fittings which have a low profile exterior designed to permit tape coating shall be primed and wrapped with an underground type pipe tape following recommendations of the coupling or fitting manufacturer.

Couplings and fittings that cannot be properly taped shall be enclosed in either a spaced mold manufactured for the purpose or a shroud of reinforced kraft paper and filled with either polyurethane foam having a cellular structure that will not absorb water, cold applied dielectric compound or hot applied bituminous compound not exceeding 135 degrees C in application temperature.

3.5 ELECTRICAL ISOLATION OF STRUCTURES

3.5.1 Insulating Fittings

Insulating flanges and couplings shall be installed aboveground, or within manholes, wherever possible, but an insulating device that electrically separates a pipeline shall not be installed in a confined area where a combustible atmosphere may collect unless precautions are taken to prevent arcing such as by means of externally located lightning arresters, grounding cells, or other means. Insulating flanges and couplings in lines entering buildings shall be located at least 300 mm above grade or floor level. Pipelines`entering buildings either below or above ground shall be electrically isolated from the structure wall with an electrically isolating gas tight wall sleeve.

3.5.2 Gas Distribution Piping

Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short circuit to another structure or to a foreign structure may occur, and at other locations as indicated.

3.5.3 Electrical Isolation

Chilled and hot water, line supply and return piping, and line conduit: electrical isolation shall be provided at each building entrance, and at other locations as indicated.

3.5.4 Copper Piping

Copper piping shall be electrically isolated at both ends of the pipe run.

3.6 DISSIMILAR METALS

3.6.1 Underground Dissimilar Piping

Buried piping of dissimilar metals including new and old steel piping, excepting valves, shall be electrically separated by means of electrically insulating joints at every place of connection. The insulating joint, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the joint.

3.6.2 Underground Dissimilar Valves

Dissimilar ferrous valves in a buried ferrous pipeline, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the valve. Brass or bronze valves shall not be used in a buried ferrous pipeline.

3.6.3 Aboveground Dissimilar Pipe and Valves

If the dissimilar metal pipe junction, including valves, is not buried and exposed to atmosphere only, the connection or valve, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of three diameters on each side of the junction.

3.7 CASING

Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically insulated from the casing and annular space sealed against incursion of water.

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SECTION 16710

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SECTION 16710

PREMISES DISTRIBUTION SYSTEM

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/TIA/EIA-568-A	(1995) Commercial Building Telecommunications Cabling Standard
EIA ANSI/TIA/EIA-569	(1990) Commercial Building Standard for Telecommunications Pathways and Spaces
EIA ANSI/TIA/EIA-606	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
EIA ANSI/TIA/EIA-607	(1994) Commercial building Grounding and Bonding Requirements for Telecommunications
EIA TSB 67	(1995) Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems

IBM PUBLICATION CORPORATION (IBM)

IBM GA27-3361-07	(1987) LAN Cabling System - Planning and Installation
IBM GA27-3773-1	(1987) Cabling System Technical Interface Specifications

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-80-576	(1994) Communications Wire and Cable for Wiring of Premises
ICEA S-83-596	(1994) Fiber Optic Premises Distribution Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORY (UL)

UL 50	(1995) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

The premises distribution system shall consist of inside-plant horizontal, riser, and backbone cables and connecting hardware to transport telephone and data (including LAN) signals between equipment items in a building.

1.3 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 0 to 60 degrees C and in the range of 0 to 95 percent relative humidity, noncondensing.

1.4 QUALIFICATIONS

1.4.1 Minimum Contractor Qualifications

All work under this section shall be performed by and all equipment shall be furnished and installed by a certified Telecommunications Contractor, hereafter referred to as the Contractor. With the exception of the coaxial Cable Television System and furnishing and installing conduit, electrical boxes, and pullwires, this work shall not be done by the Electrical Contractor. The Contractor shall have the following qualifications in Telecommunications Systems installation:

a. The experienced installer is the Contractor or an entity engaged by the Contractor, as an employee, subcontractor, or sub-subcontractor for performance of a particular installation, application, or activity. The experienced installer shall have a minimum of 3 years experience in the application, installation and testing of the specified type and rating of systems and equipment.

b. All supervisors and installers assigned to the installation of this system or any of its components shall have qualifications of a factory certified Category 5 and/or fiber optic technician from each equipment manufacturer that they are qualified to install and test the provided products. General electrical trade staff (electricians) shall not be used for the installation of the premises distribution system cables and associated LAN hardware.

c. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified Category rating and type of copper and fiber optic cable and components. An experienced installer shall also be defined as one having satisfactorily completed a minimum of five previous projects, similar in size to this project, and familiar with the precautions required, and with requirements as specified herein.

1.4.2 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract will be from manufacturers that have a minimum of 3 years experience in producing the types of systems and equipment specified.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO.

Lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings, 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, and a list of spare parts recommended for stocking.

SD-04 Drawings

Premises Distribution System; GA.

Detail drawings including a complete list of equipment and material. Detail drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack details, elevation drawings of telecommunications closet walls, outlet face plate details for all outlet configurations, sizes and types of all cables, conduits, and cable trays. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

Record Drawings; GA.

Record drawings for the installed wiring system infrastructure per EIA ANSI/TIA/EIA-606. The drawings shall show the location of all cable terminations and location and routing of all backbone and horizontal cables. The identifier for each termination and cable shall appear on the drawings.

SD-06 Instructions

Manufacturer's Recommendations; GA.

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations, prior to installation shall be provided. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

SD-08 Statements

Test Plan; GA.

Test plan defining the tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to the proposed test date. The test plan must be approved before the start of any testing. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

Qualifications; GA.

The qualifications of the Manufacturer, Contractor, and the Installer to

perform the work specified herein. This shall include proof of the minimum qualifications specified herein. Documentation of qualifications and test equipment proficiency shall be provided to Vandenburg AFB 30 CS/SCXP and SCMTS before installation of any telecommunications cabling, hardware, or equipment.

SD-09 Reports

Test Reports; GA.

Test reports in booklet form with witness signatures verifying execution of tests. Test results will also be provided on 89 mm diskettes in ASCII format. Reports shall show the field tests performed to verify compliance with the specified performance criteria. Test reports shall include record of the physical parameters verified during testing. Test reports shall be submitted within 7 days after completion of testing.

SD-13 Certificates

Premises Distribution System; GA.

Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-A, EIA ANSI/TIA/EIA-569, and EIA ANSI/TIA/EIA-606 standards.

Materials and Equipment; GA.

Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

Installers; GA.

The Contractor shall submit certification that all the installers are factory certified to install and test the provided products. Documentation of qualifications and test equipment proficiency shall be provided to Vandenburg AFB 30 CS/SCXP and SCMTS before installation of any telecommunications cabling, hardware, or equipment.

SD-18 Records

Record Keeping and Documentation; GA.

Documentation on cables and termination hardware in accordance with EIA ANSI/TIA/EIA-606.

1.6 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.

1.7 OPERATION AND MAINTENANCE MANUALS

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

1.8 RECORD KEEPING AND DOCUMENTATION

1.8.1 Cables

A record of all installed cable shall be provided in hard copy format and on electronic media using Windows based computer cable management software per EIA ANSI/TIA/EIA-606. A licensed copy of the cable management software including documentation, shall be provided. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility per EIA ANSI/TIA/EIA-606.

1.8.2 Termination Hardware

A record of all installed patch panels and outlets shall be provided in hard copy format and on electronic media using Windows based computer cable management software per EIA ANSI/TIA/EIA-606. A licensed copy of the cable management software including documentation, shall be provided. The hardware records shall include only the required data fields per EIA ANSI/TIA/EIA-606.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

2.2 UNSHIELDED (UTP) AND SHIELDED (STP) TWISTED PAIR CABLE SYSTEM

2.2.1 Cable Insulation

For each individual Category 5 cable, the insulation material used on each pair shall be exactly the same in all physical, electrical, and chemical respects. All UTP 4 pairs shall be insulated (4x0) with 100 percent Fluorinated Propylene (FEP) for non-plenum cables. All STP 4 pairs shall be insulated (4x0) with 100 percent Screened Twisted-Pair (ScTP) with an overall shield for rooms 119 through 124. Both (UTP) FEP and (STP) ScTP type insulated cables shall be specified to handle transmission speeds at a minimum of 100 MHz, and shall be Category 5. The use of Teflon insulated, plenum rated Category 5 cable is acceptable for both plenum and non-plenum applications. If Teflon insulated plenum cable is used by the Contractor, it shall be Type 4x0, where all four pairs are Teflon insulated, and specified to handle transmission speeds at a minimum of 100 MHz. Type 3x1 and 2x2 insulated cables shall not be acceptable.

2.2.2 Riser Cable

Riser cable shall meet the requirements of ICEA S-80-576 and EIA

ANSI/TIA/EIA-568-A for Category 3 100-ohm unshielded twisted pair (UTP) cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Conductors shall be solid untinned copper 24 AWG. Cable shall be rated CMR per NFPA 70.

2.2.3 Horizontal Cable

Horizontal cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A for Category 5, four-pair 100 ohm, 24 gauge American Wire Gauge (AWG), Unshielded Twisted Pair (UTP) and Shielded Twisted Pair (STP) horizontal cable, with insulation type FEP or Teflon (CMP) for UTP or Plenum rated, and ScTP for STP cable, as specified on the drawings. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and Category 5 performance level. Conductors shall be solid untinned copper 24 AWG. Cable originating from communication room 117 to rooms 119 through 124 shall be STP rated CMG per NFPA 70. Cable with any part distributed exposed on the overhead cable tray shall be CMP per NFPA 70; otherwise, it shall be rated CMG per NFPA 70 if the entire length is in conduit or any part is exposed in cable tray under raised floors not used as plenums.

2.2.4 Connecting Hardware

Connecting and cross-connecting hardware shall be minimum Category 5 shielded or unshielded, as required. Hardware shall be in accordance with and EIA ANSI/TIA/EIA-568-A.

2.2.4.1 Telecommunications Outlets

Wall and desk outlet plates shall come equipped with the minimum number of modular jacks as indicated by the respective symbol shown on Legend sheet E1.0. All modular jack faceplates shall have a built-in cover for label inserts. Modular jacks shall be the same category, and unshielded or shielded, as the cable they terminate and shall meet the requirements of EIA ANSI/TIA/EIA-568-A. Modular jack pin/pair configuration shall be T568B per EIA ANSI/TIA/EIA-568-A. Modular jacks shall be unkeyed, for both shielded and unshielded jacks. The unshielded and shielded plug-in style modular jack shall be one that can accept 4-pin, 6-position, RJ-11 type and 8-pin, 8-position, RJ-45 type connectors without causing damage to the outlet jack. Faceplates shall be provided and shall be impact resistant plastic. For additional information on faceplates, refer to paragraph 3.1.3.1 "Faceplates". Mounting plates shall be provided for system furniture and shall match the system furniture in color. Outlet assemblies used in the premises distribution system shall consist of modular jacks assembled into both simplex, duplex, and triplex outlet assemblies in single or double gang covers as indicated on the drawings. All modular jacks shall conform to the requirements of EIA ANSI/TIA/EIA-568-A, Category 5. All modular jacks utilized in communications room 117 wall area outlets and rack-mounted patch panels and in wall area outlets in rooms 119, 120, 121, 122, 123, and 124 shall be type shielded modular jacks. Wall outlet plates, at +1220 AFF, shall have "lug type" faceplate connectors.

2.2.4.2 Patch Panels

Unshielded and shielded patch panels shall be Category 5 rated, 480 mm (19 inch) rack mounted, with an attached wire management device. The front panel shall consist of 8-pin, eight-position, RJ-45 modular unshielded or shielded jacks, as required. The rear panel shall consist of color-coded,

110-type, insulation displacement connections. The rear of the patch panel shall have a wire management system installed for the proper routing of installed cables. A wire management system shall also be provided between each patch panel for proper routing of patch cords. The required patch panels shall have a minimum of 48 ports, but must provide for at least 10 percent expansion capability, sized in respect to the amount of cables terminated to the patch panel, that shall include 110 cross-connect patch cords and premises horizontal 4-pair UTP cables. There shall also be a duplicate patch panel provided, meeting the same requirements as the first, for telecommunications interface as described on the drawing riser diagrams. Shielded patch panels shall be required only in communications room 117. Jack pin/pair configuration shall be T568B per EIA ANSI/TIA/EIA-568-A. All Jacks shall be unkeyed. Panels shall be labeled with alphanumeric x-y coordinates.

2.2.4.3 Patch Cords

Patch cords shall be cable assemblies consisting of 4-pair flexible, twisted pair stranded wire unshielded (except in communications room 117) with eight-position (4-pair) 110 patch plugs at each end for cross-connecting 110 to 110 terminal blocks, and with eight-position modular RJ-45 plugs at each end for cross-connecting at patch panels. In communications room 117, only patch cords with modular plugs shall be shielded Sctp type and with shielded RJ-45 plugs; patch cords with 110 patch plugs shall not be shielded. Patch cords with modular RJ-45 plugs shall include protective rubber boots at each end. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall be color-coded, red for voice, and lavender for data. Any alarm or environmental analog bypasses shall be yellow. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per EIA ANSI/TIA/EIA-568-A. Patch cords shall be unkeyed. Patch cords shall be Category 5 and shall be factory assembled (shielded patch cords shall not be field-terminatd). Patch cords shall not exceed a length of 6 meters (20 feet), each.

2.2.4.4 Terminal Blocks

Terminal blocks shall be wall mounted wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings. Blocks shall be type 110 which meet the requirements of EIA ANSI/TIA/EIA-568-A for category 5. Blocks shall be mounted on standoffs and shall include cable management hardware. Insulation displacement connectors shall terminate 22 or 24 gauge solid copper wire as a minimum, and shall be connected in pairs so that horizontal cable and connected jumper wires are on separate connected terminals.

2.3 CABLE TELEVISION SYSTEM

2.3.1 Cable Television Coaxial Cable

The coaxial cable shall have a characteristic impedance of 75 ohms nominal. Cable shall have shielding which provides minimum 95 percent coverage. Velocity of propagation shall be 85 percent nominal. RG-11/U cable and RG-6/U cable shall be used as indicated on the drawings. Coaxial cable construction shall conform to NEC Article 820 for type CATVP cable. Temperature ratings for cable shall be -40 degrees F to +140 degrees F, with attenuation rating remaining stable from 0 percent to 100 percent relative humidity. All cable components shall be premium, able to

withstand the environment the cable is installed in for a minimum of 20 years. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicting verifying organization or performance level.

2.3.2 Cable Television Connectors

Connectors for RG-6/U and RG-11/U coaxial cable shall be F-type connectors designed for usage with the coaxial cable specified. Connectors shall be either the crimp-on or solder type.

2.4 FIBER OPTIC CABLE SYSTEM

2.4.1 Backbone Cable

2.4.1.1 Multimode

Multimode fiber optic backbone cable shall meet the requirements of EIA ANSI/TIA/EIA-568-A and ICEA S-83-596 for 62.5/125 micrometer multimode graded index optical fiber cable. Numerical aperture for each fiber shall be a minimum of 0.275. Cable construction shall be tight buffered type. Individual fibers shall be color coded for identification. Cable shall be imprinted with fiber count and aggregate length at regular intervals. Cable shall be rated OFNR per NFPA 70 if it is not installed in the overhead cable tray outside of the communications room, otherwise it shall be rated OFNP per NFPA 70.

2.4.2 Connecting Hardware

2.4.2.1 Connectors

Connectors shall be SC type with ceramic ferrule material with a maximum insertion loss of .5 dB. Connectors shall meet performance requirements of EIA ANSI/TIA/EIA-568-A. Connectors shall be field installable. Connectors shall utilize adhesive for fiber attachment to ferrule. Connectors shall terminate fiber sizes as required for the service.

2.4.2.2 Patch Panels

Patch panels shall be a complete system of components by a single manufacturer, and shall provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Patch panels shall be 480 mm (19 inch) rack mounted panels. Patch panels shall provide strain relief for cables. Panels shall be labeled with alphanumeric x-y coordinates. Patch panel connectors and couplers shall be the same type and configuration as used elsewhere in the system.

2.4.2.3 Patch Cords

Patch cords shall be cable assemblies consisting of flexible optical fiber cable with connectors of the same type as used elsewhere in the system. Optical fiber shall be the same type as used elsewhere in the system. Patch cords shall be complete assemblies from manufacturer's standard product lines.

2.5 EQUIPMENT RACKS

2.5.1 Floor Mounted Open Frame

Floor mounted equipment racks shall have frame sizes of 515 mm W x 121 mm D

x 2133 mm H (20.25" W x 4.75" D x 84" H) and be welded steel relay racks with uprights to mount equipment 480 mm (19 inches) wide. Uprights shall be 75 mm deep channel, 32 mm wide, drilled and tapped 12-24 in a 13 mm pattern. Racks shall be provided with a standard top crossmember, and predrilled base plate to allow floor fastening. Provide 6.35 mm diameter x 76.2 mm long anchor bolts to fasten racks to floor. Open frame equipment racks shall be 2.1 m in height and factory painted gray. AC outlets shall be provided as shown.

2.5.2 Cable Guides for Racks and Backboards

Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 480 mm (19 inch) equipment racks, or on the plywood backboards. Cable guides shall consist of ring or bracket-like devices mounted on rack panels, or wireways mounted on plywood backboards, for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks, and wireways to plywood backboards, by screws and/or nuts and lockwashers. Cable guides shall not exceed 50 percent fill.

2.5.3 Wall Mounted Cabinets

Wall mounted cabinets shall conform to UL 50 and have boxes constructed of zinc-coated sheet steel with dimensions not less than shown on drawings. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum openings to the box interiors. Boxes shall be provided with 19 mm plywood backboard painted white or a light color. A duplex AC outlet shall be installed within the cabinet.

2.6 EQUIPMENT MOUNTING BACKBOARD

Plywood backboards shall be constructed of 20 mm ACX plywood and be coated on both sides and edges with fire retarding, insulating varnish. Plywood backboards shall be sized as shown, painted with white or light colored paint.

2.6.1 Backboard Configuration

Provide both vertical and horizontal cable management rings and panels on the backboard as required under paragraph 2.6.3 "Cable Guides", of this specification, and as indicated on the drawings.

2.7 TELECOMMUNICATIONS OUTLET BOXES

Electrical boxes for telecommunication outlets shall be 117 mm square by 67 mm deep with minimum 9 mm deep single or two gang plaster ring as shown. Provide to each outlet box a minimum 21 mm conduit.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with EIA ANSI/TIA/EIA-606. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07270 FIRESTOPPING. Conduits, outlets and raceways shall be installed in

accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Wiring shall be installed in accordance with EIA ANSI/TIA/EIA-568-A and as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring, and terminal blocks and outlets shall be marked in accordance with EIA ANSI/TIA/EIA-606. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation. Conduit ends shall be reamed to eliminate sharp edges and terminated with an insulated bushing. The interior area of cable trays shall be free of burrs, sharp edges, or projections that can damage cable insulation. Do not exceed 50 percent fill in cable trays.

3.1.1 Horizontal Distribution Cable

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall be continuous and uninterrupted and shall have no bridge taps, branches, splices, or "Y" connections at any point. Fiber optic cables shall be installed either in conduit or through type cable trays to prevent microbending losses. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 300 mm (12 inches) shall be maintained when such placement cannot be avoided. Maintain a minimum separation of 1220 mm (4 feet) from dry type transformers. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered. In raised floor areas, cable shall be installed after the flooring system has been installed. No single section of conduit shall be longer than 30 meters (100 feet) or contain more than two 90 degree bends between junction boxes or pull points. The inside radius of a bend in conduit shall be at least six times the internal diameter. A proper cable lubricant, approved by the Base Communications Squadron, shall be applied at the manufacturer's recommended rate during the installation of the cable assemblies into conduits.

3.1.2 Riser and Backbone Cable

Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced. All vertical cable runs in duct or on ladder shall be tied with plastic straps or lacing twine at the top of the run and at least every 900 mm vertically to prevent cable strain.

3.1.3 Telecommunications Outlets

3.1.3.1 Faceplates

The faceplate shall have a built-in cover for label inserts. As a minimum, the information provided on each faceplate for each jack shall consist of the faceplate manufacturer's approved labels to label each jack as to its function and shall include a unique number to identify cable link.

3.1.3.2 Cables

Unshielded twisted pair and shielded twisted pair cables shall have a minimum of 150 mm of slack cable loosely coiled into the telecommunications outlet boxes. Coaxial cables shall have a minimum of 100 mm slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

3.1.3.3 Pull Cords

Pull cords shall be installed in all conduit serving telecommunications outlets which do not initially have fiber optic cable installed.

3.1.4 Terminal Blocks

Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas for cable guides shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized.

3.1.5 Unshielded and Shielded Twisted Pair Patch Panels

Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares. Cable guides shall be provided above, below, and the rear of patch panels for termination of 110 patch cords, and between each panel.

3.1.6 Fiber Optic Patch Panels

Patch panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 10 percent spares. A slack loop of fiber shall be provided within each panel. Loop shall be 900 mm in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.7 Equipment Racks

Open frame equipment racks shall be bolted to the floor slab with anchor bolts. Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

3.1.8 Rack Mounted Equipment

Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

3.2 TERMINATION

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.

3.2.1 Unshielded Twisted Pair Cable

Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels. No cable shall be unterminated or contain unterminated elements. Pairs shall remain twisted together to within the proper distance from the termination as specified in EIA ANSI/TIA/EIA-568-A. The amount of untwisting shall not exceed 13 mm (0.5 inches) for Category 5 cables, and 25 mm (1.0 inch) for Category 3 cables. Remove only as much cable jacket as is required for termination and trimming. Conductors shall not be damaged when removing insulation. Wire insulation shall not be damaged when removing outer jacket.

3.2.2 Shielded Twisted Pair Cable

Each cable shall be terminated on Category 5 shielded RJ-45 jacks at the wall area outlet and at Category 5 shielded patch panels. Cables shall be grounded at patch panels using manufacturer's recommended methods. Shield shall be continuous patch panel to wall outlet jack termination. Wire insulation shall not be damaged when removing shield.

3.2.3 Coaxial Cable

Home run horizontal type station cables shall be terminated at each end. Backbone cables shall be terminated with appropriate connectors or end-of-line terminators as required. Backbone and horizontal cable shield conductor shall be grounded to communications ground at only one point and shall not make electrical contact with ground anywhere else.

3.2.4 Fiber Optic Cable

Each fiber shall have connectors installed. The pull strength between the connector and the attached fiber shall be not less than 11.3 kg. The mated pair loss, without rotational optimization, shall not exceed 1.0 dB. Fiber optic connectors shall be installed per EIA ANSI/TIA/EIA-568-A.

3.3 GROUNDING

Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with EIA ANSI/TIA/EIA-607 and Section 16415 ELECTRICAL WORK, INTERIOR. Equipment racks shall be connected to the electrical safety ground.

3.4 ADDITIONAL MATERIALS

The Contractor shall provide the following additional materials required for facility startup.

a. 10 of each type outlet.

b. 10 of each type cover plate.

c. 1 of each type terminal block for each telecommunications closet.

d. 4 Patch cords of 3 meters for each telecommunications closet.

e. 1 Set of any and all special tools required to establish a cross connect and to change and/or maintain a terminal block.

3.5 ADMINISTRATION AND LABELING

3.5.1 Labeling

3.5.1.1 Labels

All labels shall be in accordance with EIA ANSI/TIA/EIA-606.

3.5.1.2 Cable

All cables will be labeled using color labels on both ends with encoded identifiers per EIA ANSI/TIA/EIA-606.

3.5.1.3 Termination Hardware

All workstation outlets and patch panel connections will be labeled using color coded labels with encoded identifiers per EIA ANSI/TIA/EIA-606.

3.6 TESTING

Materials and documentation to be furnished under this specification are subject to inspections and tests. All components shall be terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any tests. The tests shall be performed in the presence of and/or verified by Government Quality Assurance Personnel, the Contracting Officer, or by knowledgeable 30th Communications Squadron personnel. Contact 30 CS/SCMTS for assistance. Any discrepancies noted during testing shall be corrected, and those tests rerun, within 14 days. Contractual acceptance testing shall begin no later than two weeks prior to cutover. The cabling system shall be installed to provide color coding, labeling, and documentation in compliance with TIA/EIA-606. A copy of all documentation, to include as-built shop drawings and floor plans with conduits, cable trays, cabling routes, installed equipment, and specified interconnections between LAN systems, shall be provided to the Contracting Officer and the Base 30 CS/SCXP personnel. One copy of a floor plan showing the facility's final cable distribution runs, with associated labeling, shall be left folded and inside a binder in the telecommunications rooms.

3.6.1 Test Plan

The test plan shall define milestones for each test, equipment, personnel, facilities, and supplies required. The test plan shall include the detailed test procedures to be completed, cross referenced to the specific contractual requirements, stated herein and in the drawings. The plan shall also include steps for verification of station records and cable locations for all stations. All test results data shall be uploaded to a PC and printed out. An electronic file and a hard copy of all Test results shall be provided to the Contracting Officer.

3.6.2 Test Reports

A test report in booklet form detailing the results of all testing, with witness signatures verifying execution of tests, shall be delivered to the Government within seven days after completion of each phase of testing. The report shall contain sign-off/completion sheets for each test indicating test results, reason for failure, and signature blocks for both

the Contractor and Government witness. Test sheets shall have minimum:

a. Name of person(s) conducting the test
b. Name of person(s) witnessing the test
c. Type of test being performed
d. Name, model and serial number of the test equipment
e. Calibration date of the test equipment

3.6.3 Test Equipment

The contractor shall supply and maintain the necessary test equipment to accomplish the following tests. All test equipment shall meet or exceed the standards, specifications and parameters as stated in this document and TIA/EIA TSB 67. The Contractor shall maintain current calibration of all test equipment during the entire testing period. Calibration shall be accomplished according to the manufacturer's specifications. Provide field testers, as recommended by TIA/EIA TSB 67. The field tester manufacturer shall make available to the Contracting Officer a simple procedure for verifying, reporting, and recording the consistency of the field tester in the field. Field testers shall be capable of reporting data at all measured points and uploading the data to a PC and printer.

3.6.4 Unshielded and Shielded Twisted Pair Tests

All shielded and unshielded metallic cable pairs, and the shield for shielded twisted pair, shall be tested for proper identification, correct pin configuration, continuity, and integrity of the shield. Testing shall be bi-directional and include, as a minimum, four test parameters which are Wire Map, Length, Attenuation, and NEXT (Near-end Crosstalk) loss. A Pass or Fail on a parameter shall be determined by the allowable limits for that parameter, as described by TIA/EIA TSB 67. All opens, shorts, crosses, grounds, reversals, and shield integrity, in addition to Fails in any of the four Test Parameters, shall be corrected as recommended by the TIA/EIA TSB 67 standard. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet. Horizontal wiring shall be tested from and including the termination device and all cross-connects in the communications closet to and including the modular jack in each room. Backbone wiring shall be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective communications closets. These tests shall be completed and all errors corrected as required by the TIA/EIA TSB 67 standard.

3.6.5 Category 5 Circuits

All category 5 cable runs shall be tested in accordance with TIA/EIA TSB 67. Testing shall be done using the TSB 67 basic link test and channel tests procedures for Level II testing. Testing equipment used shall meet the Level II accuracy requirements of EIA TSB 67. The tests shall be accomplished between each outlet jack and the associated telecommunications closet/telephone backboard. Cables which contain failed circuits shall be replaced and retested until they Pass specified tests. There shall not be any defective pairs in the final installation of the telecommunications cabling. Testing shall be performed with both ends terminated per section 4 of TIA/EIA TSB 67.

3.6.6 Coaxial Cable

Cable shall be tested for continuity, shorts and opens. Characteristic impedance shall be verified over the range of intended operation. Cable

length shall be verified. Cable shall be sweep tested for attenuation over the range of intended operation.

3.6.7 Fiber Optic Cable

Unless stated otherwise, tests shall be performed from both ends of each circuit. Connecters shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist. Each circuit leg and complete circuit shall be tested for insertion loss at 850 and 1300 nm using light source similar to that used for the intended communications equipment. High-resolution optical time domain reflectometer (OTDR) tests shall be performed from one end of each fiber. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

-- End of Section --

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SECTION 16711

TELEPHONE SYSTEM, OUTSIDE PLANT

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 228	(1993) Steel Wire, Music Spring Quality
ASTM C 338	(1993) Softening Point of Glass
ASTM D 2239	(1994) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA ANSI/EIA/TIA-455-25B	(1996) FOTP-25 Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies
EIA ANSI/EIA/TIA-455-30B	(1991) FOTP-30 Frenquency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity
EIA ANSI/EIA-455-33A	(1987) FOTP-33 Fiber Optic Cable Tensile Loading and Bending Test
EIA ANSI/TIA/EIA-455-41A	(1993) FTOP-41 Compressive Loading Resistance of Fiber Optic Cable
EIA ANSI/EIA/TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
EIA ANSI/EIA/TIA-455-47B	(1992) FOTP-47 Output Far Field Radiation Pattern Measurement
EIA ANSI/EIA/TIA-455-51A	(1991) FOTP-51 Pulse Distortion Measurement of Multimode Glass Optical Fiber Information Transmission Capacity
EIA ANSI/EIA/TIA-455-53A	(1990) FOTP-53 Attenuation by Substitution Measurement for Multimode Graded-Index Optical Fibers or Fiber Assemblies Used in Long Length Communications Systems
EIA ANSI/EIA-455-65	(1988) FOTP-65 Optical Fiber Flexure Test

EIA ANSI/EIA-455-81A	(1992) FOTP-81 Compound Flow (Drip) Test for Filled Fiber Optic Cable
EIA ANSI/EIA/TIA-455-82B	(1992) FOTP-82 Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-56-434	(1983; R 1991) Polyolefin Insulated Communication Cables for Outdoor Use

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

RURAL ELECTRIFICATION ADMINISTRATION (REA)

REA Bulletin 1755I-100	(1991; Rev thru Supple 11 Nov 92) List of Materials Acceptable for Use on Telephone System of REA Telephone Borrowers
REA Form 522	(1993) General Specification for Digital, Stored Program Controlled Central Office Equipment
REA PC-2	(1995) Splicing Copper and Fiber Optic Cables
REA PC-4	(1976) Acceptance Tests and Measurements of Telephone Plant
REA PE-22	(1982) Aerial and Underground Telephone Cable
REA PE-33	(1985) Shield Bonding Connectors
REA PE-39	(1993) REA Specification for Filled Telephone Cables
REA PE-60	(1979) Trunk Carrier Systems
REA PE-74	(1985) Filled Splice Closures
REA PE-87	(1994) Terminating (TIP) Cable
REA PE-89	(1993) Filled Telephone Cables with Expanded Insulation
REA TE&CM 635	(1988; Addenda 1 thru 4) Construction of Aerial Cable Plant
REA TE&CM 641	(1973) Construction of Buried Plant
REA TE&CM 644	(1983) Design and Construction of Underground Cable (Physical Plant)

REA TE&CM 823	(1980; R Aug 1990) Electrical Protection by Use of Gas Tube Arrestors

UNDERWRITERS LABORATORIES (UL)

UL 497	(1995; Rev thru May 1996) Protectors for Paired Conductor Communication Circuits

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO.

Data lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of the detail drawings and not later than two 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-04 Drawings

Telephone System; GA.

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. Detail drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the cable system has been coordinated and will properly support the switching and transmission systems identified in the specification and drawings. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operations. System drawings showing final configuration, including the location, gauge, pair, duct and innerduct arrangement, or conductor assignment of outside plant, and protector and connector blocks layout at the termination points after installation.

SD-08 Statements

Test Plans; FIO.

Test plans shall define all tests required to ensure that the system meets specified required. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.

SD-09 Reports

Acceptance Tests; FIO.

Test reports in booklet form showing all field tests performed, upon completion and testing of the installed system.

Installation Procedures; GA.

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations, prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

SD-13 Certificates

Telephone System; FIO.

Where materials or equipment are specified to conform to the standards or publications and requirements of FCC, REA, ANSI, ASTM, NFPA, EIA, or UL, proof that the items furnished under this section of the specification conform to the specified requirements.

1.3 DELIVERY AND STORAGE

All cable shall be shipped on reels. The diameter of the drum shall be at least 13 times the diameter of the cable. The reels shall be substantial and so constructed as to prevent damage during shipment and handling. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel, or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing. The inner end shall be fastened so as to prevent the cable from becoming loose during installation. End seals shall be applied to each of the cables to prevent moisture from entering the cable. The reels with cable shall be suitable for outside storage conditions when the temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, 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 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 2 years prior to bid opening. Each major component of equipment shall have the manufacturer's name and type identified on the equipment.

2.2 BACKBOARD EQUIPMENT

2.2.1 Copper Conductor Type, Main Distribution Frame (MDF)

The MDF provided shall be a modular type and shall meet all requirements of REA Form 522. The MDF shall be floor mounted, made of steel, and treated to resist corrosion.

2.2.1.1 Connector Blocks

Main frame connector blocks consisting of flame-retardant molded plastic fastened to a metal mounting bar, shall be provided to terminate 400 pairs

of outside plant cable. Connector blocks shall be of the size which are able to terminate and protect at least 400 pairs, per vertical, on a 2.1 m (7 foot) high MDF. The connector blocks shall be of 100-pair block size and equipped with protection modules. The connector blocks shall be 24-gauge stub type equipped with a field cable stub, housing for termination and protector modules, and access for cross-connecting to inside wiring.

2.2.1.2 Protector Modules

The protector modules shall be of the three-electrode gas tube type. Protection modules shall be classified as light, medium, heavy, or maximum duty depending on their performance in categories of impulse life, maximum surge impulse and 60 Hz current carrying capacity as specified in REA TE&CM 823. The gas modules shall be fail-short and shall shunt high voltage to ground in less than 100 microseconds, shall have an external spark gap, and shall comply with UL 497.

2.2.2 Fiber Optic Patch Panel

The patch panel shall provide a location for maintenance and cross-connecting of fiber optic cables. The panel shall be constructed of 0.125 inch minimum thick aluminum and have connectors which interface the inside plant fiber optic jumper cable with the outside plant fiber optic cable. Panels shall be equipped with engraved laminated plastic nameplates above each connector.

2.3 CABLE

2.3.1 Copper Conductor Cable

Copper conductor cable shall conform to the following:

2.3.1.1 Underground

REA PE-39 for cable smaller than 400 pair, and REA PE-39 or REA PE-89 for cable 400 pair or larger.

2.3.1.2 Screened

Screened cable shall comply with REA PE-89.

2.3.2 Fiber Optic Cable

Reeled fiber optic cable shall contain number of fibers as indicated and shall be of continuous manufacture with no factory splices in the fiber.

2.3.2.1 Compatible Components

Materials used within a given cable shall be compatible with all other materials used in the same cable when such materials come into intimate contact. All cable components used shall have no adverse affect on optical transmission or on the mechanical integrity characteristics of the fiber placed in the cable. All materials used shall be nontoxic, noncorrosive, and shall present no dermal hazard. The minimum required material components applied to fiber optic cable construction are central core or sheath strength member, color-coded optical fibers, inner jacket, pulling strength members, and outer jacket.

2.3.2.2 Cable Cores

A central core member or sheath strength member shall be included to serve as a cable core foundation to reduce strain on the fibers but not to serve as a pulling strength member. The material of the central core member shall be nonmetallic. The sheath strength member may be either metallic or nonmetallic. The metallic strength element shall be spring quality music type wire per ASTM A 228. The nonmetallic strength element shall be glass filament.

2.3.2.3 Optical Fiber

Single-mode optical fibers shall be contained in the cable. The single-mode fiber shall be step index optical glass. The core diameter, if an addressable parameter, shall be 8.5 plus or minus 2 microns. If the core diameter is not addressed, then the mode field diameter shall be 10 microns plus or minus 1 micron. The cladding diameter shall be 125 microns plus or minus 5 microns. The core-cladding offset shall be less than 1 micron. The minimum tensile strength of the fiber after primary protective coating shall be greater than 344 MPa (50,000 psi). The softening point of the clad material of the optical fiber shall be 1630 degrees C plus or minus 50 degrees C in compliance with ASTM C 338.

2.3.2.4 Optical Fiber Coatings

The optical fiber shall be coated with a suitable material to preserve the intrinsic high tensile strength of the glass fiber. The outside diameter of the coated optical fiber shall be 250 microns plus or minus 15 microns. The coating material shall be readily removable, mechanically or chemically, without damaging the optical fibers when the removal is desired.

2.3.2.5 Color Coding

The primary protective coated fiber shall be coated with a color-code coating for individual fiber identification. The maximum outside diameter of color-code coated fiber shall be less than 300 microns.

2.3.2.6 Fiber Protection

The color-code coated fibers shall be surrounded with either loose buffer tubes, channels or other innovative design, or in a tight buffer construction, for protection from external mechanical and environmental influences. The interior of the tube shall be filled with a suitable gel-filling compound to prevent water migration. The loose tube buffering, channel or other innovative design, or tight buffer construction, shall be color coded for the tube identification. The material of the buffering tube shall be PVC, mylar, nylon, or a functionally equivalent material.

2.3.2.7 Tint Requirements

The color concentrates or tints used to color the optical fibers and the buffer tubes shall not be susceptible to migration and chemical reaction with gel-filling compound.

2.3.2.8 Buffer Tubes

The buffer tubes shall be located concentrically around the cable central core member and covered with a black, low or medium density polyethylene inner jacket in accordance with ICEA S-56-434.

2.3.2.9 Filling Compound Requirements

The inner jacket interior and buffer cavity shall contain a gel-type filling compound. The filling compound shall be of suitable viscosity so that it shall protect the optical fibers against the ingress of water and/or soluble chemicals and shall not flow at the temperature of up to 65 degrees C. The gel-filling compound shall be colorless, electrically nonconducting, inert gel-type, waterproof, nontoxic, with no dermal hazards, and compatible chemically and mechanically with all cable components and associated splice hardware materials to which it may make contact. The gel filling shall be removable, as required, using commercially available products under field conditions.

2.3.2.10 Tensil Strength

The cable shall contain a nonconductive central strength member as a well as a layer of aramid type yarn encircling the cable core. The strength member shall provide a maximum pulling load of 1335 Newtons.

2.3.2.11 Outer Jacket

Black, low or medium density, high-molecular weight, polyethylene materials shall be applied longitudinally over all the inner jacket and sheathing strength member to form the cable outer jacket, in accordance with ICEA S-56-434. The outer jacket shall be smooth, concentric, non-nutrient to fungus, and free from holes, splits, blisters, or other imperfections. The overall outside cable diameter shall not exceed 19.1 mm (0.75 inch).

2.3.2.12 Armor Shield

A metallic armor shield shall be provided for additional tensile strength, rodent protection, and high crush and moisture resistance. The material of the metallic armoring shall be metallic tube or steel corrugation, coated with anti-corrosion material, and sealed at the longitudinal overlap.

2.3.2.13 Fiber Differentiation

The individual optical fiber shall be easily and positively identified from the buffer tube color code and the optical fiber primary coating color code.

2.3.2.14 Cable Labeling

The outer jacket shall bear the manufacturer's name, year of manufacture, and length marker. The length marking shall employ continuous four- or five-digit number in meters, such as:

Manufacturer's Name - Year
XXXX meter

The markings shall be repeated clearly and distinguishably, on every meter on the cable outer jacket. The marking ink shall be fully compatible with the jacket material, nonsmearing, nonwater soluble, abrasion resistant, and durable enough to withstand field handling during placement and subsequent operations.

2.3.2.15 Attenuation

The optical attenuation of each optical fiber in the reeled cable shall be no greater than 1.0 dB/km within a peak emissive region of 850 to 1300 nm.

The attenuation shall be measured on completed cable reel length, and normalized linearly to 1 km. The measurement method shall be in accordance with EIA ANSI/EIA/TIA-455-46A or EIA ANSI/EIA/TIA-455-53A.

2.3.2.16 Bandwidth

Each optic fiber within the cable (reeled) shall have its bandwidth measured between 3 dB optical power points, as compared to a reference signal, for a light source with a peak optical emissive region of 850 to 1300 nm. The effective system bandwidth of at least 1 GHz-km is required. The effective system bandwidth is the bandwidth length product calculated from the measured bandwidth multiplied by the cable length raised to the negative length dependance factor (or gamma factor). Gamma shall be in the range of 0.85 to 0.9. The bandwidth measurement shall be in accordance with EIA ANSI/EIA/TIA-455-30B frequency domain or EIA ANSI/EIA/TIA-455-51A time domain.

2.3.2.17 Numerical Aperture

The numerical aperture of each optical fiber shall be 0.2 plus or minus 0.02 within an optical emissive region of 850 to 1300 nm. The method of numerical aperture measurement shall be in accordance with EIA ANSI/EIA/TIA-455-47B.

2.3.2.18 Bending Tolerance

The cable shall be able to withstand bending to a minimum radius of ten times the cable outer diameter with no tensile load applied, and of twenty times the cable outer diameter with maximum tensile load applied during installation, without damage to cable components or degradation of the optical fiber performance at room temperature.

2.3.2.19 Tensile Load Tolerance

The fiber optic cable shall withstand a pull force of at least 1780 Newtons, to be applied to the pulling strength member during the installation and a tensile load of at least 300 Newtons during operation without incurring any damage or detriment to fiber optic cable and optical performance. The tensile strength test shall be per EIA ANSI/EIA-455-33A.

2.3.2.20 Cyclic Flexing Tolerance

The fiber optic cable shall withstand at least twenty bending cycles at minimum bend radius without damage to the fiber optic cable components or degrading optical performance. The cyclic flexing test shall be in accordance with EIA ANSI/EIA-455-65.

2.3.2.21 Crush Resistance

The minimum crush resistance of the fiber optical cable shall be greater than 650 Newton/cm without damage to cable components or degrading optical performance. The crush resistance test shall be in accordance with EIA ANSI/TIA/EIA-455-41A.

2.3.2.22 Impact Resistance

The fiber optic cable shall be capable of withstanding twenty impacts, at a force of 5 Newtons-meters, without damage to cable components, or degradation of optical performance. The impact resistance test shall be in

accordance with EIA ANSI/EIA/TIA-455-25B.

2.3.2.23 Gel Compound Temperature Tolerance

The optic cable shall be tested for the ability of the gel-filling compound in the interior of the inner jacket and buffer to resist flow at the temperature range of minus 40 degrees C to 60 degrees C in accordance with EIA ANSI/EIA-455-81A.

2.3.2.24 Fluid Penetration Test

The optic cable shall be capable of preventing the entry and axial migration of 62 kPa (9 psi) pressurized water when subjected to fluid penetration testing in accordance with EIA ANSI/EIA/TIA-455-82B.

2.3.2.25 Performance Requirements

The fiber optic cable shall comply with the mechanical performance requirements herein while used in duct applications where the temperature varies minus 20 degrees C to plus 60 degrees C. Optical performance degradation shall be less than 5 percent of the optical performance requirements in the temperature range of minus 20 degrees C to plus 60 degrees C. The fiber optic cable shall not be damaged in storage where the temperature may vary from minus 40 degrees C to plus 65 degrees C.

2.3.2.26 Defects and Imperfections

Fiber optic cables shall be free of material and manufacturing defects, and of dimensional nonuniformities which would seriously impair the functionality of the cables. The fiber optic cables shall also be free from surface imperfections and internal defects which would prevent them from meeting the mechanical and transmission requirements of this specification.

2.4 CONDUIT

Conduit as specified in Section 16415 ELECTRICAL WORK, INTERIOR and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and as shown shall be furnished.

2.5 INNERDUCT

Innerduct shall be SIDR 11.5 polyethylene plastic pipe conforming to ASTM D 2239.

2.6 CLOSURES

2.6.1 Copper Conductor Closures

2.6.1.1 Underground

The underground closure shall be suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. The closure shall be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. The encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Filled splice cases shall comply with REA PE-74.

2.6.2 Fiber Optic Closures

2.6.2.1 Underground

The underground closure shall be suitable to house a splicer organizer in a protective housing into which can be poured an encapsulating compound. The closure shall be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. The encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure.

2.7 CABLE TERMINALS

2.7.1 Cross-Connect Cable Terminal

Cross-connect cable terminals shall be weatherproofed for outdoor use and suitable for pole, pad, or stake mounting. The terminal shall be equipped with mounting columns and distribution rings for jumper-wire routing. The terminal shall be of aluminum or steel construction and ribbed for strength.

2.8 CABLE SPLICES, CONNECTORS, CABLE ASSEMBLIES, AND ORGANIZERS

2.8.1 Copper Cable Splices

Copper cable splices shall consist of a moisture resistant, two- or three-wire connector held rigidly in place to assure maximum continuity. The correct connector size shall be used to accommodate the cable gauge of the cable to be supplied. The connectors used shall be listed in REA Bulletin 1755I-100.

2.8.2 Fiber Optic Cable Splices

Fiber optic cable splices shall consist of a fusion splice where two fibers are thermally fused together forming a continuous fiber length.

2.8.3 Pre-Connectorized Single-Fiber Cable Assembly

Fiber cable connectors shall be the biconical type, field installable, self-aligning, and self-centering. The connectors shall be terminated on a 10-foot length of single-fiber cable. The single-fiber cable shall contain a buffered optical fiber of the same type and specification as that used in the multifiber cable.

2.8.4 Fiber Optic Splice Organizer

The splice organizer shall be suitable for housing fiber optic fusion splices in a neat and orderly fashion. The closure shall allow for a minimum of one meter of cable to be neatly stored without kinks or twists. The splice organizer in the closure shall provide individual strain relief for each splice. The case shall be suitable for reentry, if required for future maintenance or modification, without damage to the cable or splices. All required splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors shall be provided in the organizer kit.

2.9 MISCELLANEOUS ITEMS

2.9.1 Shield Connectors

Shield connectors shall make a stable, low-impedance electrical connection between the shield of the communications cable and a conductor such as a strap, bar, or wire. The connector shall be made of tin-plated tempered brass. Shield bond connectors shall comply with REA PE-33.

2.9.2 Grounding Braid

Grounding braid shall provide low electrical impedance connections for dependable shield bonding. The braid shall be made from flat tin-plated copper.

2.9.3 Cable Warning Tape

Cable warning tape shall be a minimum of 75 mm (3 inches) wide, orange in color, and suitable for buried applications. The warning tape shall be continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" at not more than 1.2 m (48 inches) intervals.

2.9.4 Cable Warning Sign

Cable warning sign shall consist of one stake mounted warning sign. The stake shall be driven into undisturbed soil and the sign shall be mounted to the stake in accordance with the manufacturer's instructions.

PART 3 EXECUTION

3.1 INSTALLATION

All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown. All necessary interconnections, services, and adjustments required for a complete and operable telephone system shall be provided. All installation work must be done in accordance with the safety requirements set forth in the general requirements of IEEE C2 and NFPA 70.

3.1.1 Underground Cable

Underground cable installation shall be accomplished in accordance with the requirements set forth in REA TE&CM 644.

For cable installed in ducts and conduit, a cable feeder guide shall be used between the cable reel, and the face of the duct and conduit to protect the cable and guide it into the duct and conduit as it is payed off the reel. As the cable is payed off the reel, it shall be inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being kinked or crushed. A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. Cable shall be hand fed and guided through each manhole. As the cable is payed off the reel into the cablefeeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Where the cable is pulled through a manhole, additional lubricant shall be applied at all intermediate manholes. Dynamometers or load-tension instruments shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed upon a cable during installation shall not be such that the cable is twisted or stretched.

3.1.2 Innerduct

Innerduct shall be pulled through existing duct-manhole system in continuous sections. Splices, joints, couplings, or connections of any type will not be allowed between manholes. Innerduct shall be sealed with polyurethane foam duct seal. This material shall be inserted between the innerduct and the duct. In those innerducts in which cables are placed this material shall also be inserted between the cable and the innerduct. Only one cable shall be installed in a given innerduct. Existing and new unoccupied innerducts shall be trimmed leaving 50 mm exposed.

3.1.3 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of REA PE-60.

3.2 SPLICING

3.2.1 Copper Conductor Splices

Copper conductor cable splicing shall be accomplished in accordance with REA PC-2.

3.2.2 Fiber Optic Splices

Fiber optic splicing shall be in accordance with the manufacturer's recommendation and shall exhibit an insertion loss not greater than 0.2 dB for fusion splices .

3.3 GROUNDING

Except where specifically indicated otherwise, all exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals shall be grounded.

3.3.1 Master Ground Bar (MGB)

The Contractor shall provide a copper MGB which shall be the hub of the building basic grounding system, providing a common point of connection for ground from outside cable, DF, and communications room equipment. Terminate all incoming telephone cable shields on the MGB. The Contractor shall establish a MGB to ground resistance, including ground, of 10 ohms or less.

3.3.2 Incoming Outside Plant Cables

3.3.2.1 Main Distribution Frame Ground Bar

All shields of cable stubs to connector block shall be bonded to the Main Distribution Frame Ground Bar (DFB). The DFB shall be established by the Contractor and shall consist of a copper ground bar at the bottom of the MDF used as the connection point for the cable stub shields to connector blocks and DF protector assemblies.

3.3.2.2 Shields

The shields of all incoming cables shall not be bonded across the splice to the cable stubs. The shields of the incoming cables shall be grounded in

the vault.

3.3.3 Main Distribution Frame Grounding

3.3.3.1 Protection Assemblies

The DF protector assemblies shall be mounted directly on the vertical frame ironwork. The assemblies mounted on each vertical frame shall be connected with a No. 6 AWG copper conductor to provide a low resistance path to the DFB.

3.3.3.2 MGB Connection

The DFB shall be connected to the MGB by a copper wire conductor with a total resistance of less than 0.01 total ohms.

3.3.4 Manholes

The shields of all cables in each manhole shall be bonded together by a bonding wire or ribbon. At intermediate manholes where the cable is pulled through without a sheath opening, bonds are not required. If the manhole has a lacerating bonding ribbon, the shields of cable shall be attached to it.

3.4 ACCEPTANCE TESTS

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test, and in no case shall notice be given until after the Contractor has received written Contracting Officer approval of the test plans as specified. The test plans shall define all the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.

3.4.1 Test Reports

A test report in booklet form detailing the results of all testing, with witness signatures verifying execution of tests, shall be delivered to the Government within seven days after completion of each phase of testing. The report shall contain sign-off/completion sheets for each test indicating test results, reason for failure, and signature blocks for both the Contractor and Government witness. Test sheets shall have minimum:

a. Name of person(s) conducting the test
b. Name of person(s) witnessing the test
c. Type of test being performed
d. Name, model and serial number of the test equipment
e. Calibration date of the test equipmentSub Title

3.4.2 Copper Conductor Cable

The following acceptance tests shall be performed in accordance with REA PC-4:

a. Shield continuity.

b. Conductor continuity.

c. Conductor insulation resistance.

d. Structural return loss.

e. Cable insertion loss and loss margin at carrier frequencies.

f. Shield ground for single jacketed cables.

g. DC loop resistance.

3.4.3 Fiber Optic Cable

Three optical tests shall be performed: Optical Time Domain Reflectometry (OTDR) Test, Attenuation Test, and Bandwidth Test. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single-fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single-fiber cable assembly. The following acceptance tests shall be performed for each fiber in the completed cable length. Single-mode fibers do not require Bandwidth Test.

3.4.3.1 OTDR Test

The OTDR test shall be used to determine the adequacy of the cable installations. The OTDR tests will show any irregularities, such as discontinuities, micro-bendings, improper splices, for the cable span under test. Hardcopy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 1 km minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature.

3.4.3.2 Attenuation Test

End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 850 nanometer light source at one end and the optical power meter on the other end. These tests will be used to verify that the cable system attenuation requirements are met. The measurement method shall be in accordance with EIA ANSI/EIA/TIA-455-53A.

3.4.3.3 Bandwidth Test

The end-to-end bandwidth of all multimode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with EIA ANSI/EIA/TIA-455-30B.

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SECTION 16721

FIRE DETECTION AND ALARM SYSTEM

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

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1994; Supple 1) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code
NFPA 72	(1993) National Fire Alarm Code
NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL-04	(1994) Fire Protection Equipment Directory
UL 6	(1993) Rigid Metal Conduit
UL 38	(1994; Rev Jan 1994) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
UL 228	(1993) Door Closers-Holders, with or without Integral Smoke Detectors
UL 268	(1989; Rev May 1989) Smoke Detectors for Fire Protective Signaling Systems
UL 464	(1990) Audible Signal Appliances

UL 467	(1993) Grounding and Bonding Equipment
UL 521	(1993) Heat Detectors for Fire Protective Signaling Systems
UL 797	(1993) Electrical Metallic Tubing
UL 864	(1991; Rev thru May 1994) Control Units for Fire-Protective Signaling Systems
UL 1242	(1983; Rev thru Jul 1993) Intermediate Metal Conduit

1.2 GENERAL REQUIREMENTS

1.2.1 Scope

This section provides requirements for protective signaling fire alarm system. The system shall provide control for supervisory fire detection and alarm throughout the facility, sprinkler functions as well as fire detection, alarm and monitoring for the facility. Refer to specification SECTION 15300 SPRINKLER SYSTEMS, FIRE PROTECTION and contract drawings for reference information on sprinkler system.

The system consists of a Radionics 9124 Fire Alarm Control Panel (FACP), associated detection monitoring and signaling devices as well as connections for auxiliary functions such as air handler shutdown as described in drawings and specifications. Drawings and specifications indicate a general arrangement of the system and are not to be considered as a complete design. The contractor is required to make a complete operable system based on the descriptions of systems and components provided. Detailed shop drawings are required to be submitted and approved prior to purchase of the equipment.

A fully addressable U.L. listed and approved fire alarm control system in accordance with project specifications shall be utilized for building fire detection and alarm. System shall utilize analog type "smart" smoke sensors and other addressable devices as indicated on plans and specifications. System shall be U.L. listed.

Specific layout and requirements for fire alarm system are as indicated on plans and in project specifications. Contractor shall be responsible for final design of fire control system. General requirements are as follows:

a. Radionics 9124 Fire Alarm Control Panel (FACP) shall monitor and control all smoke and heat detectors, manual alarm pull stations, duct smoke detectors, evacuation alarm devices (bells, strobes, etc.), addressable relay modules, as well as relay output required.

b. The fire alarm system shall also provide the following interface functions:

(1) Monitor all sprinkler system flow and tamper conditions.

(2) Shutdown HVAC units and close automatic smoke dampers, where applicable from associated duct smoke detector alarm, via connection to DDC control panels.

1.2.1.2 Description of Work

Engineer, design and provide all materials to provide a complete functional interior fire detection system, sprinklers supervisory control, including associated equipment and accessories. Provide each system complete and ready for operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of the NFPA. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories, Inc., or approved by the Factory Mutual System.

1.2.1.3 Catalog Reference

Catalog numbers (where used) are those of Radionics, Inc. Systems, Salinas, California and constitute minimum standards of performance, function and quality to be furnished and installed by contractor. Salient characteristics for each specified equipment item are provided. All equipment shall be as approved by Underwriter`s Laboratories, Factory Mutual and local (Fire) authorities.

1.2.1.4 Tie-in to Central Monitoring

Project scope includes tie-in of facility fire alarm and detection system for "By-Zone" annunciation of fire alarm signals plus a common trouble signal to base central system. A Radionics Digital Communicator "transmitter" panel (DCP) with battery back-up power, compatible with base`s central monitoring system shall be furnished, installed and tested for site tie-in. Annunciation shall be accomplished via 2 standard telephone lines run into DCP. DCP shall be capable of transmitting signals/messages to central station (i.e., at fire station, police dept., inc. shop, etc.).

Contractor shall be responsible for supplying output contacts at FACP, all wiring termination and tie-in to central monitoring system, including all necessary software programming at monitoring system.

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be 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 can provide service within 24 hours.

1.2.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.2.3 Keys and Locks

Locks shall be keyed alike.

1.2.4 Tags

Tags with stamped identification number shall be furnished for keys and

locks.

1.2.5 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.

1.2.6 Compliance

The fire detection and internal alarm system and the central reporting system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.2.7 Manufacturer's Services

Services of a manufacturer's representative who is experienced in the installation, adjustment, testing, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.3 SYSTEM DESIGN

1.3.1 Operation

The fire alarm and detection system shall be a complete, Class B supervised fire alarm system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to signal line circuits (SLC), Style 6, in accordance with NFPA 72. Alarm indicating appliances shall be connected to indicating appliance circuits (IAC), Style X in accordance with NFPA 72. A two-loop conduit system shall be provided so that if any one conduit and all conductors contained in that conduit are severed all IAC, or SLC on that circuit shall remain functional. A two-loop system is not applicable to the central fire alarm communication center from the local panels. All textual, audible, and visual appliances and systems shall comply with NFPA 72.

Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits.

a. Sufficient memory shall be provided to perform as specified and as shown for addressable system.

b. Individual identity of each addressable device shall be provided for the following conditions:

alarm
trouble
open
short
appliances missing/failed
remote detector - sensitivity adjustment from the panel for smoke detectors

c. All addressable devices shall have the capability of individually being disabled or enabled from the panel.

1.3.2 Operational Features

The system shall have the following operating features:

a. Electrical supervision of alarm SLC and IAC.

b. Electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel.

c. Trouble buzzer and trouble lamp (light emitting diode or neon light) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator lamp. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. Transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but shall provide a trouble signal when disconnected and a restoration signal when reconnected.

e. Evacuation alarm silencing switch or switches which, when activated, will silence alarm devices, but will not affect the zone indicating lamp nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed zone and the alarm devices will be activated.

f. Electrical supervision of circuits used for supervisory signal services. Supervision shall detect any open, short, or ground.

g. Confirmation or verification modules used on smoke detection initiating circuits. The modules shall interrupt the transmission of an alarm signal to the system control panel for a factory set period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal if present will be sent immediately to the control panel. All fire alarm devices other than smoke detectors shall be prohibited on circuits controlled by confirmation or verification modules.

h. Zones for alarm SLC shall be arranged as indicated on the contract drawings.

1.3.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of signals over the station telephonic fire reporting system. The signals shall be different for each zone.

b. Visual indications of the alarmed zones on the fire alarm control panel annunciator.

c. Continuous sounding of alarm notification appliances throughout the building.

f. Deactivation of the air handling units throughout the building.

1.3.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.3.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FI0" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Battery; GA.

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; FIO.

Voltage drop calculations for signaling appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Spare Parts; GA.

Spare parts data for each different item of material and equipment specified, not later than 2 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Qualifications; GA.

Qualifications, with verification of experience and license number, of a Registered Professional Engineer with at least 4 years of current experience in the design of the fire protection and detection systems. This engineer must perform the various specification items required by this

section to be performed by a registered Professional Engineer.

SD-04 Drawings

Fire Alarm Reporting System; GA.

Detail drawings, signed by the Registered Professional Engineer, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

Detailed point-to-point wiring diagram, signed by the Registered Professional Engineer, showing all points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated or controlled by the panel.

SD-06 Instructions

Fire Alarm Reporting System; GA.

Six copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. 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. Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. Instructions shall be approved prior to training.

Training; FIO.

Lesson plans and training data, in manual format, for the training courses.

SD-08 Statements

Test Procedures; GA.

Detailed test procedures, signed by the Registered Professional Engineer, for the fire detection and alarm system 60 days prior to performing system tests.

SD-09 Reports

Testing; GA.

Test reports in booklet form showing all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document all readings, test results and indicate the final position of controls.

SD-13 Certificates

Equipment; GA.

Certified copies of current approvals or listings issued by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Installer; FIO.

The Contractor shall provide documentation demonstrating that its fire detection and alarm system installer has been regularly engaged in the installation of fire detection and alarm systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this contract. Such documentation shall specifically include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Documentation shall indicate the type of each system installed and include a written certificate that each system has performed satisfactorily in the manner specified for a period of not less than 12 months following completion. All such data shall be submitted 30 days prior to commencement of installation for approval of the Contracting Officer. Listing of the installer under "Protective Signaling Services - Local, Auxiliary, Remote Station Proprietary (UUJS)" of UL-04 shall be accepted as equivalent proof of compliance with the foregoing experience requirements.

1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, and any other contaminants.

PART 2 PRODUCTS

2.1 RADIONICS 9124 CONTROL PANEL

Control Panel shall comply with all the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing all components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for all lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Separate alarm and trouble lamp shall be provided for each zone alarm located on exterior of cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meters or lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each SLC initiating circuit shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones. Loss of power, including any or all batteries, shall not require the reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

2.1.1 Control Panel

The Radionics 9124 Fire Alarm Control Panel (FACP) shall process all input signals, sequence the levels of alarm and provide outputs to activate alarm signals, provide detection and interface with digital communication panel and activate alarms. The system shall have a standby battery supply to provide a minimum of forty-eight (48) hours of emergency power, plus 15 minutes full alarm and shall be calculated with a 150 percent safety margin. The system shall be a software-based programmable Radionics or equal.

2.1.1.1 Central Control Module

This module shall control, supervise, and continuously monitor the entire system through the use of a microcontroller. This module shall include a back lit liquid crystal display (LCD) with up to 32 characters of alphanumeric information. Each fire alarm system address point shall have a custom identifying message programmed at FACP software. Message shall appear at panels 32 character LCD display if an alarm or trouble condition occurs at address. Contractor shall be responsible to generate proposed custom device message in tabulated form and obtain field engineer`s approval prior to programming and functional testing of entire system.

The Radionics 9124 FACP shall include the following features:

a. All required switches for silencing and sequencing system Alarm and Trouble signals, displaying custom location messages and resetting.

b. A 256-event non-volatile history buffer shall be provided to store any abnormal event and shall have the ability to be downloaded at any time for hard copy records. The 256-event history buffer shall be a non-volatile RAM memory with dual lithium battery backup. History events shall be stored with time, date and a description of the abnormal event. The system shall provide information of sensor contamination levels, fire levels, and other data necessary for future reference and analysis.

c. This system shall be fully field programmable and not required factory assistance for operating reconfiguration of any kind.

d. Radionics 9124 FACP shall be provided with a minimum of 25% expansion capability of the entire capacity of the system.

e. All fire alarm controls are to be coordinated by this panel.

f. System shall be compatible of accepting a modem module for direct off-site system monitoring over a telephone line.

2.1.2 Cabinets

Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate all units. Cabinets shall have manufacturer's standard finish and color.

2.1.4 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each terminal marked for identification.

2.2 STORAGE BATTERIES

Storage Batteries shall be provided and shall be the sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 48 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be sized to deliver 50 percent more ampere/hours based on a 48 hour discharged rate than required for the calculated capacities. Battery cabinet shall be a separate compartment within the control panelor a separate cabinet. Batteries in the control panel shall be located at the bottom of the panel. Battery shall be provided with overcurrent protection in accordance with NFPA 72.

2.3 BATTERY CHARGER

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly if a high rate switch is provided. Charger shall be located in control panel or battery cabinet.

2.4 MANUAL FIRE ALARM STATIONS

Manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into alarm-initiating circuits. Stations shall be installed on semi-flush mounted outlet boxes. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be painted the same color as the fire alarm manual stations. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset.

2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors shall be connected into alarm initiating circuits. Detectors located in concealed locations (above ceiling, etc.) shall have a remote visible indicator lamp. Installed devices shall conform to the classification of the area. Addressable fire detecting devices except flame detectors shall be dynamically supervised and uniquely identified in the control panel.

2.5.2 Smoke Detectors

Detectors shall be designed for detection of abnormal smoke densities.

Smoke detectors shall be ionization and photoelectric type. Detectors shall contain a visible indicator lamp that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making all wiring connections. Detectors that are in concealed (above false ceilings, etc.) locations shall have a remote visible indicator lamp.

2.5.2.1 Ionization Detectors

Ionization detectors with a dual chamber shall be responsive to both invisible and visible particles of combustion. One chamber shall be a reference chamber and the second a sampling chamber. Detectors containing radium shall not be provided. Detectors shall not cause an alarm condition due to anticipated fluctuations in relative humidity. The sensitivity of the detector shall be field adjustable to compensate for operating conditions. Detector shall require no replacement or readjustment to restore it to normal operation after an alarm condition. Each detector shall be capable of withstanding ambient air velocity up to 1.5 meters per second (300 fpm) in accordance with UL 268. Detectors shall have at least a two-stage sensitivity setting, with detectors initially set for normal sensitivity. A lower sensitivity shall be available for each detector. The lower sensitivity shall be within the limits established for that detector by UL or FM.

2.5.2.2 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating between 1.9 and 2.4 percent per foot when tested in accordance with UL 268.

2.5.2.3 Addressable Point Monitor Module (APMM)

The APMM shall monitor any normaly open contact configuration. This module shall provide an output signal, with each poll of the device, to the CCU identifying all the current status of the addressable device. The output signal shall distinguish the following circuit conditions: Normal (open contact), short circuit (close contact), and open circuit (field wire break). Provide means to set the individual address.

2.5.2.4 Duct Detectors

Duct detectors are provided under Section 15951 Direct Digital Control for HVAC. Duct detectors shall provide analog output to Panel. Detectors shall be provided with means to set the individual sensors address. Duct detectors shall be remote reset at the fire alarm control panel.

2.6 NOTIFICATION APPLIANCES

Audible appliances shall be heavy duty and conform to the applicable requirements of UL 464. Devices shall be connected into alarm indicating circuits and shall have a separate screw terminal for each conductor. Devices shall be painted red .

2.7 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box recessed grill and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a minimum sound rating of at least 85 dBA at 3.048 m (10 feet). Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grills.

2.7.1 Visual Notification Appliances

Visual notification appliances shall have high intensity optic lens and flash tubes. Strobes shall flash at approximately 1 flash per second and a minimum of 1 candela (8,000 peak candle power). Strobe shall be semi-flush mounted. When more than two strobes are within an individuals field of view they shall be synchronized.

2.7.2 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. All units shall be factory assembled. Any other audible indicating appliance employed in the fire alarm systems shall be approved by the authority having jurisdiction.

2.9 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

2.9.1 Conduit

Conduit and fittings shall comply with UL 6, UL 1242 and UL 797.

2.9.2 Wiring

Wiring for 120V ac power shall be No. 12 AWG minimum. Wiring for low voltage dc circuits shall be No. 16 AWG minimum. Power wiring (over 28 volts) and control wiring shall be isolated. All wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except rigid plastic conduit may be used under slab-on-grade. All conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to alarm initiating, supervisory circuits, and alarm indicating circuits are prohibited. T-tapping using screw terminal blocks is allowed for addressable systems.

2.9.3 Special Tools and Spare Parts

Special tools necessary for the maintenance of the equipment shall be furnished. Two spare fuses of each type and size required and five spare lamps and LED's of each type shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Fuses and lamps shall be mounted in the fire alarm panel.

2.9 Field Programming

Provide a system that is field programmable and configurable through the use of manufacturer`s supplied software. Field programming shall allow expansion, changing, devices, and custom location messages. Provide a complete set of software required to operate the system.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power to each building fire alarm system shall be provided. The primary power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. No more than one conductor shall be installed under any screw terminal. All circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors are prohibited in the system. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 300 mm nor more than 2 m above the finished floor. All manually operable controls shall be between 900 mm to 1.1 m above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be installed in accordance with NFPA 72. Detectors shall be at least 300 mm from any part of any lighting fixture. Detectors shall be located at least 900 mm from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in free space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 900 mm, sway bracing shall be provided.

3.1.5 Notification Appliances

Notification appliances shall be mounted a minimum of 2.4 m above the finished floor unless limited by ceiling height or otherwise indicated.

3.2 SPRINKLER INTERFACE

Each sprinkler system flow switch contacts shall be connected to initiate an alarm separately in accordance with NFPA 13 requirements. All flow switches shall be monitored individually by an Addressable Point Monitor Module (APMM).

Each set of supervised valve contacts shall be connected to the fire alarm panel to provide a distinct signal (different from a circuit "Trouble Condition") when valve is in an off-normal position in accordance with NFPA 72 requirements. Activation of a valve tamper switch shall produce a panel trouble condition. APMM shall be used to monitor valve tamper switches individually.

3.2 OVERVOLTAGE AND SURGE PROTECTION

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. All cables and conductors which serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

3.3 GROUNDING

Grounding shall be provided to building ground . Maximum impedance to ground shall be 25 ohms.

3.4 TESTING

The Contractor shall notify the Contracting Officer 30 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise all tests. The Contractor shall furnish all instruments and personnel required for the tests.

3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance. Tests shall include the meggering of all system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional.

3.4.2 Acceptance Test

Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that all previous deficiencies have been corrected. The test shall include the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of all wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault

k. Short circuit faults

l. Stray voltage

m. Loop resistance

3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period shall consist of one training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover all of the items contained in the operating and maintenance instructions.

-- End of Section --

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SECTION 16725

INTRUSION DETECTION SYSTEMS

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 C2	(1993) National Electrical Safety Code
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.92	(1981; R 1987) Data Encryption Standard
ANSI X3.154	(1988) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices

DEPARTMENT OF DEFENSE (DOD)

DOD 3235.1	(Rev H) Test & Evaluation of System Reliability Availability and Maintainability - A Primer

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 170	(1957) Electrical Performance Standards - Monochrome Television Studio Facilities
EIA 232-E	(1991) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
EIA 310-D Associated Equipment	(1992) Cabinets, Racks, Panels, and

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms

IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

MILITARY HANDBOOKS (MIL-HDBK)

MIL-HDBK 759	(Rev B) Human Factors Engineering Design For Army Materiel

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993) Rigid Metal Conduit
UL 639	(1993; Rev Jul 1994)Intrusion-Detection Units
UL 796	(1993) Printed-Wiring Boards

1.2 SYSTEM DESCRIPTION

1.2.1 General

The Contractor shall configure the Intrusion Detection System (IDS) as described and shown including Government Furnished Equipment. 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. The system shall provide operator interaction and dynamic process manipulation, including overall system supervision, and control. Alarm data shall be obtained from local processors which are located within the protected zone. The system shall have the capability of de-activating one zone at a time from the control panel.

1.2.2 Overall System Reliability Requirement

The system, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF), as defined in IEEE Std 100, of at least 2000 hours continuous operation. Mean time between failure shall be calculated based on the configuration specified in paragraph Overall System Reliability Calculations.

1.2.3 Alarm Classifications

1.2.3.1 Intrusion Alarm

The annunciation of an alarm resulting from the detection of a specified target and which represents an attempt to intrude into the protected area.

1.2.3.2 Nuisance Alarm

The annunciation of an alarm resulting from the detection of an alarm stimuli but which does not represent an attempt to intrude into the protected area.

1.2.3.3 Environmental Alarm

The annunciation of an alarm resulting from environmental conditions which exceed those specified.

1.2.3.4 False Alarm

The annunciation of an alarm when there is no alarm stimuli.

1.2.4 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 equates to 49 successful detections out of 50 tests or 96 successful detections out of 100 tests. A false alarm rate of less than 1 false alarm per sensor per 5 days shall be provided at this probability of detection.

1.2.5 Standard Intruder

The system shall be able to detect an intruder that has the characteristics of a 5th percentile U.S. Army female as defined in MIL-HDBK 759. The intruder shall be dressed in a long-sleeve shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.

1.2.6 Standard Intruder Movement

Movement of the standard intruder is defined as any movement; such as walking, running, crawling, rolling, and jumping. The system shall detect a standard intruder moving through a protected zone in the most advantageous manner for the intruder.

1.2.7 Electrical Requirements

Electrically powered IDS equipment shall operate on 120 or 240 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.

1.2.8 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.

1.2.9 Sensor Wiring and Communication Circuit Surge Protection

Inputs shall be protected against surges induced on sensor wiring. Outputs shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. All communications equipment shall be protected against surges induced on any communications circuit. All cables and conductors, except fiber optics, which serve as communications circuits from the control panel 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 900 mm 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.

1.2.10 Power Line Conditioners

A power line conditioner shall be furnished for the control panel 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.

1.2.11 System Reaction

1.2.11.1 System Response

All alarms shall be annunciated on the displays within 1 second of their occurring at a local processor. This response time shall be maintained during system heavy load.

1.2.11.2 System Heavy Load Definition

System heavy load conditions are defined as the occurrence of alarms at a rate of 10 alarms per second. For the purpose of system heavy load definition, the system shall consist only of all control panel equipment and all local processors required by the design. The system heavy load conditions as specified shall have 50 percent of the alarms occurring at a single local processor with the remaining alarms distributed among the remaining local processors. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second.

1.2.12 Environmental Conditions

1.2.12.1 Interior, Controlled Environment

All system components except the control panel installed in interior locations having controlled environments shall be rated for continuous operation under ambient environmental conditions of 1.7 to 48.9 degrees C (35 to 120 degrees F) dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.2.12.2 Interior, Uncontrolled Environment

All system components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 17.8 to plus 48.9 degrees C (0 to 120 degrees F) dry bulb and 10 to 95 percent relative humidity, noncondensing.

1.2.12.3 Control panel

Control panel equipment, unless designated otherwise, shall be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 degrees C (60 to 85 degrees F) and a relative humidity of 20 to 80 percent.

1.2.13 System Capacity

The system shall monitor and control the number of inputs and outputs shown and shall include an expansion capability of a minimum of 25 percent.

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 is specifically identified in this specification shall be delivered in accordance with the CONTRACT CLAUSES, SPECIAL CLAUSES, Section 01330 SUBMITTAL PROCEDURES. 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. Control panel installation, block diagrams, and wiring diagrams.

c. Local processor installation, typical block, and wiring diagrams.

d. Local processor physical layout and schematics.

e. Sensor wiring and installation drawings.

f. Details of connections to power sources, including power supplies and grounding.

g. Details of surge protection device installation.

i. Sensor detection patterns.

1.3.1.2 Manufacturers' Data

The data package shall include manufacturers' data for all materials and equipment, including sensors, local processors and control panel equipment provided under this specification.

1.3.1.3 Software Data

The data package shall consist of descriptions of the operation and capability of system, and application software as specified.

1.3.1.4 Certifications

All specified manufacturer's certifications shall be included with the data package.

1.3.2 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, command, 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 messages and printing formats.

i. System access requirements.

1.4 TESTING

1.4.1 General

The Contractor shall perform predelivery testing, site testing, and adjustment of the completed intrusion detection 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 IDS as specified. The training shall be oriented to the specific system being installed under this contract.

1.6 LINE SUPERVISION

1.6.1 Signal Line Supervision

All signal lines between sensors and the alarm annunciation control panel shall be supervised by the system. The system shall supervise the signal lines by monitoring changes in the direct current that flows through the signal lines and a terminating resistor. The system shall initiate an alarm in response to a current change of 10 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTM lines.

1.7 EXPERIENCE

The contractor shall submit written proof that the following experience requirements are being met.

1.7.1 Hardware Manufacturer Experience

All system components shall be produced by manufacturers who have been regularly engaged in the production of intrusion detection system components of the types to be installed for at least 5 years.

1.7.2 Software Manufacturer Experience

All system and application software shall be produced by manufacturers who have been regularly engaged in the production of intrusion detection system and application software of similar type and complexity as the specified system for at least 2 years.

1.7.3 System Installer Experience

The system shall be installed by a contractor who has been regularly engaged in the installation of intrusion detection systems of similar type and complexity as the specified system for at least 2 years.

PART 2 PRODUCTS

2.1 GENERAL 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. .

2.1.2 Enclosures

System enclosures shall be metallic as shown.

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 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.

2.1.2.3 Corrosion Resistant

System electronics to be used in a corrosive environment as defined in NEMA 250 shall be housed in metallic enclosure 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 3.2 mm (1/8 in.) thick, white with black center core. Nameplates shall be a minimum of 25 by 75 mm, with minimum 6.4 mm (1/4 in.) 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 25 by 75 mm.

2.1.4 Tamper Provisions

2.1.4.1 Tamper Switches

Enclosures, cabinets, housings, boxes, and fittings of every description having hinged doors or removable covers and which contain circuits or connections of the intrusion detection 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. Tamper switches shall be mechanically mounted to maximize the defeat time when enclosure covers are opened or removed. It shall take longer than 1 second to depress or defeat the tamper switch after opening or removing the cover. The enclosure and the tamper switch shall function together in such a manner as to 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 so concealed 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 single pole single throw type.

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. 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 intrusion detection system.

2.1.4.3 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.

2.1.5 System Component Design

IDS 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 that 25 percent with respect to dissipation ratings, maximum voltages, and current carrying capacity. Light duty relays and similar switching devices shall be solid state type or sealed electromechanical.

2.1.5.1 Modularity

The Contractor shall provide equipment designed for increase of system capability by installation of component modules. System components shall be designed to facilitate maintenance through replacement of modular subassemblies and parts.

2.1.5.2 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 the time maintenance personnel are given entrance to the IDS and begin work, until the IDS is fully functional.

2.1.5.3 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.

2.1.5.4 Electromagnetic and Radio Frequency Interference (EMI/RFI)

IDS components generating EMI/RFI shall be designed and constructed in accordance with 47 CFR 15.

2.1.5.5 Product Safety

IDS components shall conform to applicable rules and requirements of NFPA 70. IDS 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 IDS equipment.

2.1.6 Controls and Designations

Controls and designations shall be as specified in NEMA ICS 1.

2.1.7 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.

2.1.8 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.

2.1.9 Indicator Lights

Indicator lights used throughout the system shall be light emitting diodes (LED) or long life incandescent lamps. The indicator lights used shall be visible from a distance of 9.1 meters in an area illuminated to 800 lx. The indicator lights shall conform to the following color coding:

a. RED shall be used to alert an operator that a zone is in alarm and that the alarm has been acknowledged.

b. FLASHING RED shall be used to alert an operator that a zone has gone into an alarm or that primary power has failed.

c. YELLOW shall be used to advise an operator that a zone is in access.

d. GREEN shall be used to indicate that a zone is secure or that power is on.

2.1.10 Access/Secure Switches

An access/secure switch shall be used to place a protected zone in ACCESS. The switch shall consist of a double pull key-operated switch housed in a NEMA 12 equivalent enclosure. The switch shall disable all sensor alarm outputs with the exception of tamper alarm outputs within the protected zone and sensors in zones above false ceilings or other inaccessible locations as shown.

2.2 INTERIOR SENSORS

2.2.1 Balanced Magnetic Switch (BMS)

The BMS shall detect a 6.4 mm (1/4 in.) of separating relative movement between the magnet and the switch housing. Upon detecting such movement, it shall transmit an alarm signal to the alarm annunciation system.

2.2.1.1 BMS Subassemblies

The BMS shall consist of a switch assembly and an actuating magnetic 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 one million operations. The magnet assembly shall house the actuating magnet.

2.2.1.2 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.

2.2.1.3 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.

2.2.2 Glass Break Sensor

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.

2.2.2.1 Sensor Element

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. The detection pattern of a sensor element shall be circular with at least a 1.5 meter radius on a continuous pane of glass. A factory installed hookup cable of not less than 1.8 meters shall be included with each sensor. The sensor element shall not exceed 2600 square mm in mounting area. 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 location of the sensor signal processor or by command from the alarm annunciation system.

2.2.2.2 Sensor Signal Processor

The sensor signal processor shall process the signals from the sensor element(s) 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.

2.2.2.3 Glass Break Simulator

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.

2.2.3 Passive Infrared Motion Sensor

The passive infrared motion sensor shall detect changes in the ambient level of infrared emissions caused by the movement of a standard intruder within the sensor's field of view. Upon detecting such changes, the sensor shall transmit an alarm signal to the alarm annunciation system. The sensor shall detect a change in temperature of no more than 1.1 degrees C(2.0 degrees F), and shall detect a standard intruder traveling within the sensor's detection pattern at a speed of 0.091 to 2.29 meters per second across two adjacent segments of the field of view. Emissions monitored by the sensor shall be in the 8 to 14 micron range. The sensor shall be adjustable to obtain the coverage pattern shown. The sensor shall be equipped with a temperature compensation circuit.

2.2.3.1 Test Indicator

The passive infrared motion 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 such that it can only be seen when the housing is open/removed.

2.2.3.2 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 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.

2.3 ALARM ANNUNCIATION SYSTEM

The alarm annunciation system shall be configured as a modular digital computer based system as shown. The alarm annunciation system shall provide operator interface, interaction and dynamic real-time process manipulation, including overall system supervision, coordination and control. The alarm annunciation system shall consist of a control panel, alarm annunciation system, dedicated communications network, system software and application software.

2.3.1 Local Processor

The local processor shall monitor associated sensors and issue commands over supervised communication lines. The local processor shall have inputs

and outputs as shown. The local processor shall have on-board data equipment for communication with the central computer. The local processor shall include a real-time clock/calendar. The local processor shall have memory with capacity to store 1 alarm, including time of occurrence, per input. Alarms occurring during a communication outage shall be recorded and retained in the local processor memory and reported to the central memory files upon restoration of communications. The local processor shall begin the report to the central memory files within 10 seconds of communications restoration. Local processor operations shall be fully supervised by the central computer. The central computer shall detect and report any local processor failures, including communications and power problems.

2.3.1.1 Inputs

The inputs shall accept sensor on-off, open-close, or other change of state (two state data) indications.

2.3.1.2 Outputs

The outputs shall provide contact closures for momentary and maintained or latching operation as required. Closures shall have a minimum duration of 0.1 second. Output relays shall have an initial breakdown voltage between contacts and coil of at least 500 volt AC peak. Minimum contact rating shall be 1 ampere at 24 volt AC.

2.3.1.3 Local Processor Power Supply

Local processor and sensors shall be powered from an uninterruptible power source. The uninterruptible Power Source shall provide 4 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.

2.4.1.4 Year 2000 Compliant

Equipment shall be year 2000 compliant and shall be able to accurately process date/time (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centries.

2.4 WIRE AND CABLE

2.4.1 General

The Contractor shall provide all wire and cable not indicated as Government furnished equipment. All wiring shall meet NFPA 70 standards.

2.4.2 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.

2.4.3 Class 2 Low Energy Conductors

The conductor sizes specified for digital functions shall take precedence

over any requirements for Class 2 low energy signal-circuit conductors specified elsewhere.

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, ANSI C2 and as shown, and shall furnish all necessary interconnections, services, and adjustments required for a complete and operable system as specified and shown.

3.1.1 Installation

All wiring, including low voltage wiring outside the control panel, cabinets, boxes, and similar enclosures, shall be installed in rigid galvanized steel conduit conforming to UL 6. Minimum size of conduit shall be 21 mm (3/4 in.). Connections shall be tight tapered threaded. No threadless fittings or couplings shall be used. Conduit outlet boxes, pull boxes, junction boxes, conduit fittings and similar enclosures shall be cast metal or malleable iron as specified in Section 16415, with threaded hubs or bodies. Electric metallic tubing (EMT), armored cable, nonmetallic sheathed cable, or flexible conduit will not be permitted except where specifically shown. DTM 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 intrusion detection system, except where specifically noted herein. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

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 an approved sealant as recommended by the cable manufacturer 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/or brazing on factory galvanized components, such as boxes, enclosures, and conduits, shall be coated with a cold galvanized paint containing at least 95 per cent zinc by weight.

3.2 SYSTEM STARTUP

The Contractor shall not apply power to the intrusion detection system until the following items have been completed:

a. Intrusion detection system equipment items and DTM have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the intrusion detection 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 intrusion detection 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 data transmission media (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.

3.4.3 Performance Verification Test

The Contractor shall demonstrate that the completed IDS 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 request. This 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.

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SECTION 16752

ELECTRONIC ENTRY CONTROL SYSTEMS

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 CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-02	(1993) 1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(1997) National Electrical Safety Code
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.92	(1981; R 1987) Data Encryption Standard
ANSI X3.154	(1988) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1994) Surface Burning Characteristics of Building Materials

CODE OF FEDERAL REGULATIONS (CFR)

21 CFR 1020	Performance Standards for Ionizing Radiation Emitting Products
47 CFR 15	Radio Frequency Devices

DEPARTMENT OF DEFENSE (DOD)

DOD 3235.1	(Rev H) Test & Evaluation of System Reliability Availability and Maintainability - A Primer

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 232-E	(1991) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data

	Interchange
EIA 310-D	(1992) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 100	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 142	(1992) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7810	(1985) Identification Cards - Physical Characteristics
ISO 7811/1	(1985) Identification Cards - Recording Technique - Part 1: Embossing
ISO 7811/2	(1985) Identification Cards - Recording Technique - Part 2: Magnetic Stripe
ISO 7811/3	(1985) Identification Cards - Recording Technique - Part 3: Location of Embossed Characters on ID-1 Cards
ISO 7811/4	(1985) Identification Cards - Recording Technique - Part 4: Location of Read-Only Magnetic Tracks - Tracks 1 and 2
ISO 7811/5	(1985) Identification Cards - Recording Technique - Part 5: Location of Read-Write Magnetic Track - Track 3

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993) Rigid Metal Conduit
UL 294	(1994; Rev Jul 1994) Access Control System Units
UL 681	(1991; Rev thru Sep 1991) Installation and

	Classification of Mercantile and Bank Burglar-Alarm Systems
UL 796	(1993) Printed-Wiring Boards
UL 972	(1984; Rev Feb 1989) Burglary-Resisting Glazing Material
UL 1037	(1994; Rev thru Jan 1995) Antitheft Alarms and Devices
UL 1076	(1988; Rev thru Dec 1994) Proprietary Burglar Alarm Units and Systems

1.2 SYSTEM DESCRIPTION

1.2.1 General

The Contractor shall configure the electronic entry control system (EECS) as a modular, digital-computer-based as specified and as shown. The EECS shall provide operator interface, interaction, and dynamic real-time process manipulation, including overall system supervision, coordination and control. The EECS shall be Radionics Readykey system. See specification section 08700, Builders Hardware, for additional requirements. All computing devices, as defined in 47 CFR 15, shall be certified to comply with the requirements for Class A or Class B computing devices and labeled as set forth in 47 CFR 15. Electronic equipment shall comply with 47 CFR 15.

1.2.2 Overall System Reliability Requirements

The EECS, including all components and appurtenances, shall be configured and installed to yield a mean time between failure (MTBF), as defined in IEEE Std 100, of at least 2000 hours continuous operation. Mean time between failure shall be calculated based on the configuration specified in paragraph "Overall System Reliability Calculations".

1.2.3 Alarm Classifications

Definitions and requirements apply to EECS and equipment.

1.2.3.1 Intrusion Alarm

The annunciation of an alarm by the EECS when entry into an access controlled area is attempted without using EECS procedures.

1.2.3.2 Nuisance Alarm

The annunciation of an alarm resulting from the detection of an alarm stimuli, but which does not represent an attempt to intrude into the protected area.

1.2.3.3 Environmental Alarm

The annunciation of a false alarm during environmental conditions which exceed those specified.

1.2.3.4 False Alarm

The annunciation of any alarm when there is no alarm stimulus.

1.2.3.5 Fail-Safe Alarm

The EECS shall include a fail-safe capability in its critical system functions. The EECS shall monitor for proper system functions and report an alarm when a failure is detected. This shall include, but not be limited to, the monitoring of communication circuit integrity and providing self-test. When diminished functional capabilities are detected, the system shall annunciate the fault.

1.2.3.6 Power Loss Alarm

The EECS shall detect when system components experience loss of power exceeding 2 seconds, and shall annunciate an alarm. The alarm shall identify the zone experiencing the power loss. Circuitry shall be designed to fail to an alarm condition with the loss of power.

1.2.3.7 Access Control Alarm

An access control alarm shall be annunciated when the EECS detects improper use of EECS procedures or equipment.

1.2.4 Integrated System Performance Requirements

The installed and operating EECS shall perform as a complete and integrated system as specified.

1.2.4.1 False Alarm Rate

A false alarm rate of less than 1 false alarm per zone per 5 days shall be provided.

1.2.4.2 Error and Throughput Rates

Error and throughput rates shall be single portal performance rates obtained when processing individuals one at a time. If serial verification techniques or multiple attempts are required to satisfy error performance requirements, these features shall not reduce throughput.

1.2.4.3 Type I Error Rate

A Type I error means that the system denies access to an authorized, enrolled individual. The EECS Type I error rate shall be less than 1 percent.

1.2.4.4 Type II Error Rate

A Type II error means that the system grants access to an unauthorized individual. The EECS Type II error rate shall be less than 0.1 percent.

1.2.5 Definition of Passage

Passage shall be defined as ingress 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.

1.2.6 Detection Resolution

The system shall have detection resolution sufficient to:

a. Locate intrusions at each device and zone.

b. Locate failures or tampering at individual devices.

1.2.7 Electrical Requirements

Electrically powered EECS equipment shall operate on 120 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.

1.2.8 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from powerline surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

1.2.9 Device Wiring and Communication Circuit Surge Protection

All 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. All communications equipment shall be protected against surges induced on any communications circuit. All 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 1 m 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.

1.2.10 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.

1.2.11 System Reaction

1.2.11.1 System Response

All alarms shall be annunciated on the console within 2 seconds of them occurring at a local processor or devices controlled by a local processor, and within 100 milliseconds if the alarm occurs at the central processor. Alarm and status changes shall be displayed within 100 milliseconds after receipt of data by the central processor. This response time shall be maintained during system heavy load.

1.2.11.2 System Heavy Load Definition

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.

1.2.12 Environmental Conditions

1.2.12.1 Interior, Controlled Environment

All system components except the console equipment installed in interior locations having controlled environments shall be rated for continuous operation under ambient environmental conditions of 1.7 to 49 degrees C (35 to 120 degrees F) dry bulb and 20 to 90 percent relative humidity, noncondensing.

1.2.12.2 Interior, Uncontrolled Environment

All system components installed in interior locations having uncontrolled environments shall be rated for continuous operation under ambient environmental conditions of minus 17.8 to plus 48.9 degrees C (0 to 120 degrees F) dry bulb and 10 to 95 percent relative humidity, noncondensing.

1.2.12.3 Console

All console equipment shall, unless designated otherwise, be rated for continuous operation under ambient environmental conditions of 16 to 29 degrees C (60 to 85 degrees F) and a relative humidity of 20 to 80 percent.

1.2.13 System Capacity

The EECS shall have the capacity to monitor, communicate and display up to 10 alarms. The system shall identify individual sensors, switches, and terminal devices in an alarm state.

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 is specifically identified in this specification shall be delivered strictly in accordance with the

CONTRACT CLAUSES, SPECIAL CLAUSES, Section 01330 SUBMITTAL PROCEDURES. 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. Details of interconnections with IDS .

1.3.1.2 Manufacturer's Data

The data package shall include manufacturers' data for all materials and equipment, including terminal devices, local processors and security center 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 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. Central processor memory size.

b. Communication speed and protocol description.

c. Rigid disk system size and configuration.

d. Flexible disk system 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 data package shall consist of descriptions of the operation and capability of system, command, and application software as specified.

1.3.1.6 Certifications

All specified manufacturer's certifications shall be included with the data package.

1.3.1.7 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.

1.3.1.8 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.

1.3.1.9 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 EECS. 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.

1.3.1.10 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. The Contractor shall utilize data from the contract documents, Contractor's field surveys, and all 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 203.2 by 254.0 mm (8 by 10 inches) in size, of each type of graphic to be used for the completed EECS. 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.

1.3.2 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 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.

1.3.2.1 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.

1.3.2.2 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.

1.3.2.3 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 communications protocols, including data

formats, command characters, and a sample of each type of data transfer.

1.3.2.4 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, command, 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 messages and printing formats.

j. System access requirements.

1.3.2.5 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.

1.3.2.6 Final System Drawings

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the EECS 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 EECS 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 fianl 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.

1.4 TESTING

1.4.1 General

The Contractor shall perform predelivery testing, site testing, and adjustment of the completed EECS. 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 EECS as specified. The training shall be oriented to the specific system being installed under this contract.

1.6 LINE SUPERVISION

1.6.1 Signal and Data Transmission Media (DTM) Line Supervision

All signal or DTM lines between terminal devices and the alarm annunciation console 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 10 percent or greater. The system shall also initiate an alarm in response to opening, closing, shorting, or grounding of the signal and DTM lines.

1.6.2 EXPERIENCE

The Contractor shall submit written proof that the following experience requirements are being met.

1.6.2.1 Hardware Manufacturer's Experience

All system components shall be produced by manufacturers who have been regularly engaged in the production of EECS components of the types to be installed for at least 5 years.

1.6.2.2 Software Manufacturer's Experience

All system and application software shall be produced by manufacturers who have been regularly engaged in the production of EECS and application software of similar type and complexity as the specified system for at least 2 years.

1.6.2.3 System Installer Experience

The system shall be installed by a Contractor who has been regularly engaged in the installation of EECS equipment of similar type and complexity as the specified system for at least 2 years.

1.6.3 MAINTENANCE AND SERVICE

1.6.3.1 General Requirements

The Contractor shall provide all services required and equipment necessary

to maintain the entire EECS in an operational state as specified for a period of 1 year after formal written acceptance of the system, and shall provide all necessary material required for performing scheduled adjustments or other nonscheduled work.

1.6.3.2 Description of Work

The adjustment and repair of the EECS includes all computer equipment, software updates, communications transmission equipment and DTM, local processors, and access control, facility interface, and support equipment. Responsibility shall be limited to Contractor installed equipment. Provide the manufacturer's required adjustments and other work as necessary.

1.6.3.3 Personnel

Service personnel shall be certified in the maintenance and repair of similar types of equipment and 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 change in personnel.

1.6.3.4 Schedule of Work

1.6.3.4.1 Inspections

The Contractor shall perform two inspections at 6 month intervals or more often if required by the manufacturers. These inspections shall include:

a. Visual checks and operational tests of all console equipment, peripheral equipment, local processors, facility interface/actuator devices, and electrical and mechanical controls.

b. Mechanical adjustments, new ribbons, and other necessary adjustments of printers.

c. Clean system equipment, local processors, including interior and exterior surfaces.

d. Perform diagnostics on all equipment.

e. Check and calibrate each EECS device.

f. Check, test and calibrate personnel identity verification devices.

g. Run system software diagnostics and correct diagnosed problems.

h. Resolve any previous outstanding problems.

1.7 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding federal holidays.

1.8 Emergency Service

The Government will initiate service calls when the EECS is not functioning properly. Qualified personnel shall be available to provide service to the complete EECS. 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 8 hours after receiving a request for

service. The EECS shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

1.9 Operation

Performance of scheduled adjustments and repair shall include verification of operation of the EECS as demonstrated by the applicable tests of the performance verification test.

1.10 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 EECS.

1.11 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 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 accomplished.

1.12 System Modifications

The Contractor shall make 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. Modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

1.13 Software

The Contractor shall provide software updates and verify operation in the system as required. These updates shall be accomplished in a timely manner, fully coordinated with the EECS operators, 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 GENERAL 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.

2.1.2 Enclosures

System enclosures shall be metallic as shown.

2.1.2.1 Interior Terminal Device

All terminal devices to be used in an interior environment shall be housed in an enclosure that provides protection against dust, falling dirt, and dripping noncorrosive liquids.

2.1.2.3 Interior Electronics

All system electronics to be used in an interior environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 12.

2.1.2.5 Corrosion Resistant

All system electronics to be used in a corrosive environment shall be housed in enclosures which meet the requirements of NEMA 250 Type 4X.

2.1.3 Nameplates

Nameplates shall be provided for EECS equipment and devices. Laminated plastic nameplates shall be provided for central and local processors. Each nameplate shall identify the processor and its location within the system. Laminated plastic shall be 3.2 mm (1/8 inch) thick, white with black center core. Nameplates shall be a minimum of 25.4 by 76.2 mm (1 inch by 3 inches), with minimum 6.5 mm (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 shall not be required for devices smaller than 25.4 by 76.2 mm (1 inch by 3 inches).

2.1.5 Tamper Provisions

2.1.5.1 General

Enclosures, cabinets, housings, boxes, and fittings of every description having hinged doors or removable covers, and which contain circuits or connections of the EECS 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. It shall take longer than 1 second to depress or defeat the tamper switch after opening or removing the cover. 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.

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 terminal device enclosures, which must be opened to make routine maintenance adjustments to the device, shall be single pole single throw type.

2.1.5.2 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.

2.1.5.3 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.

2.1.6 System Component Design

EECS components shall be designed for continuous operation. All electronic components shall be solid state type, mounted on printed circuit boards conforming to UL 796. Circuitry shall not be so densely placed as to impede maintenance. Printed circuit board connectors shall be plug-in, quick-disconnect type. Power dissipating components shall incorporate safety margins of not less that 25 percent with respect to dissipation ratings, maximum voltages, and current carrying capacity. Light duty relays and similar switching devices shall be solid state type or sealed electromechanical.

2.1.6.1 Modularity

The Contractor shall provide equipment designed for increase of system capability by installation of component modules. 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 the time maintenance personnel are given entrance to the EECS and begin work, until the EECS 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 Electromagnetic and Radio Frequency Interference (EMI/RFI)

EECS components generating EMI/RFI shall be designed and constructed in accordance with 47 CFR 15.

2.1.6.5 Product Safety

EECS components shall conform to applicable rules and requirements of NFPA 70 and UL 294. EECS 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 EECS 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.

2.2 ELECTRONIC ENTRY CONTROL SYSTEM OPERATION

2.2.1 General

The Contractor shall furnish the EECS complete and ready for operation. The EECS shall operate in a continuous interrogation, control, and response mode. The EECS shall provide a user interface and an operator interface to control system functions. The EECS shall provide a means to enter time, date, and installation-related data such as portal numbers, portal descriptors, central processor addresses, and local processor addresses. Under normal operations, the EECS shall record transactions as they occur. This record shall include identification of the individual, location, time of day, and date. If access is denied, an access denial alarm shall be initiated and the EECS shall record reason for denial.

2.2.2 EECS Definitions

2.2.2.1 EECS Identifiers

An identifier shall be a card credential, keypad personal identification number or code, biometric characteristic or any other unique identification entered as data into the EECS database for the purpose of identifying an individual. Identifiers shall be used by the EECS for the purpose of validating passage requests for areas under the control of the EECS.

2.2.2.2 EECS Devices

A terminal device shall be any piece of equipment which gives a user the means to input identifier data into the EECS for verification. A facility interface device shall be any type of mechanism which is controlled in response to passage requests and allows passage through a portal.

2.2.3 EECS Interfaces

2.2.3.1 User Interface

The EECS shall control passage. The decision to grant or deny passage shall be based upon identifier data to be input at a specific location during the current time period. 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.

2.2.3.2 System Operator Interface

EECS operation shall be entirely automatic under control of the EECS central processor(s) and local processors except for simple control key operations required for alarm acknowledgment, zone and portal status change operations, audible or visual alarm silencing and audio annunciation. The EECS shall immediately annunciate changes in zone and portal status. The EECS shall immediately display the current status of any zone or portal upon command. While the EECS is annunciating an unacknowledged zone or portal alarm, keyboard operations at the system operator console other than alarm acknowledgment shall not be possible. The EECS 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 EECS shall immediately annunciate an alarm for that zone or portal.

2.2.4 Electronic Entry Control System Functions

The EECS shall implement the following functions under system manager/operator control.

2.2.4.4 Immediate Access Change

The EECS 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 EECS shall provide access change capability to system operators and managers with appropriate password clearance at the system operator or enrollment console.

2.2.4.5 Identifier and Terminal Tracking

The EECS shall track the movements and activity of an identifier throughout the site at any terminal device. The EECS shall use this data to generate, and store a log of this activity. The log shall be updated every time a transaction involving an identifier or terminal device is completed. The design of the EECS shall provide identifier tracking data for at least 1 year, and terminal device tracking for at least 1000 transactions without loss of log data.

2.2.4.6 Multiple Time Zones

The EECS shall provide multiple time zone access control. Personnel enrolled in the EECS 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 EECS shall provide automatic activation and deactivation of access authorization. The design of the EECS shall provide at least 4 time zones with overlapping time zones. The EECS 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 EECS 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 access outside of the authorized time zone shall initiate an access denial alarm.

2.2.4.7 Multiple Operator Levels

The EECS 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.

2.2.4.8 Output Relay Control

The EECS shall individually control and monitor the state of all output relays.

2.2.4.11 Enrollment

The EECS shall provide a method to enter personnel identifying information into the EECS database files through enrollment stations. In the case of personnel identity verification subsystems, this data shall include biometric data. The EECS 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 EECS shall fully support the enrollment function and shall be compatible with the EECS database files.

2.2.5 Electronic Entry Control System Capacities

The EECS shall be designed and configured to provide the following capacities.

2.2.5.1 Enrollees

The EECS shall be configured for 1000 enrollees. The EECS shall provide a facility-tailorable reference file database containing personal, access authorization, identifier and verification data for each enrollee as required.

2.2.5.2 Transaction History File Size

The EECS capacity shall be at least the amount of transactions for the system during 1 year without any loss of transaction data.

2.2.5.3 Number of Portals

The EECS shall monitor and control the portals shown.

2.2.5.4 Number of Output Relays

The EECS shall monitor and control the number of output relays shown.

2.2.5.5 Local Processor Interrogation

The EECS shall sequentially interrogate each local processor in the system until all processors in the system have been interrogated. The interrogation shall be repeated on a continuous basis. The EECS shall complete each interrogation cycle of all EECS local processors and associated zones and portals, and show the status of all zones, portals and local processors within 5 seconds or less exclusive of new data exchange. The local processor shall exchange new data with the central processor during each polling sequence. Alarms or data requests needed for controlling passage will be communicated immediately to the central processor. If a local processor fails to respond to an interrogation, the EECS shall annunciate a local processor off-line alarm.

2.2.5.6 Terminal Device Status

The local processor shall provide basic diagnostics of terminal devices and upon command shall communicate the status of the terminal devices to the system operator.

2.2.5.7 Facility Interface Device Status

The local processor shall communicate the status of the facility interface devices to the system operator.

2.3 ELECTRONIC ENTRY ANNUNCIATION SYSTEM

The system shall include all equipment, cabling, connectors, adapters, terminators, and appurtenances as needed for a complete and operational EECS.

2.3.1 Central Processor

The central processor shall be a digital, computer based system and shall include the central processing unit and all hardware, input/output (I/O) controllers, control circuitry, random access memory, real-time clock/calendar, software, and firmware as required to provide a fully functional processor. All components shall be housed within a single enclosure. Central processor operating speed and random access memory configuration shall be as needed to meet the response time as specified in paragraph "System Reaction". The central processor shall not include any hardware precluding the purchase of a standard maintenance and service contract from the computer manufacturer.

2.3.1.2 Diagnostics

The central processor shall incorporate built-in diagnostics implemented in

software/firmware, hardware or both. Each time the central processor is started or re-booted, it shall automatically execute a series of built-in tests and report equipment malfunctions, configuration errors, and inaccuracies on the system monitor screen and on the system printer. The EECS shall annunciate an audible alarm if the central processor fails the built-in diagnostics. Central processors used in a peer processing environment as described in paragraph "Peer Processors" shall provide continuous internal program, data memory, and hardware self test.

2.3.1.3 Real-Time Clock/Calendar

The system real-time clock/calendar shall be continuously updated and be provided with battery backup sufficient to operate for not less than 1 year without external power input. Accuracy shall be within 1/2 second per day. The real-time clock/calendar shall maintain time in a 24-hour format including seconds, minutes, hours, date, and month. The real-time clock/calendar shall be resetable by the operator, and shall update the clock/calendar in the local processors at least once every 24 hours. The real-time clock shall have at least one EIA 232-E output port to provide time data in ASCII format to other equipment in the console. The clock/calendar shall be Year 2000 compliant and shall be able to accuurately process date/time data from, into, and between the twentieth and twenty-first centuries, including leap year calculations.

2.3.1.4 Long Term Data Storage

The central processor shall include long term storage media. The central processor shall have a fixed hard disk with at least 40 megabytes of storage space and an average access time of 40 milliseconds or less. A 1.2 megabyte 133 mm (5-1/4 inch) floppy disk drive or 1.44 megabyte 90 mm (3-1/2 inch) semi-floppy disk drive shall be provided.

2.3.1.5 Graphic Display

A graphic alarm display shall be provided showing the protected facilities. Zones corresponding to the portals monitored by the system shall be highlighted on the display. The status of each zone shall be displayed using a three color display system.

a. FLASHING RED shall be used to annunciate an alarm.

b. RED shall be used to alert the operator to an alarm and that the alarm has been acknowledged.

c. YELLOW shall be used to advise the operator that a zone is under operator controlled access or that an alarm is being shunted.

d. GREEN shall be used to indicate that the zone is secure and all equipment is functioning correctly.

2.3.2 Local Processor

The local processor shall be a microprocessor controlled solid state electronic device. The local processor shall include a real-time clock/ calendar which shall be updated at least once every 24 hours by the central processor. The local processor shall monitor portal status and associated terminal device and facility interface device status, and shall communicate the status to the central processor. The local processor shall provide electric strike or other facility interface device power and control, and

an electric strike or other facility interface device release which is time adjustable from 1 to 30 seconds. The local processor shall be housed in a tamper-alarmed enclosure.

2.3.2.1 Local Processor and Enclosure Size and Weight

The local processor and its tamper-protected enclosure shall not exceed 510 mm in height by 510 mm in width by 205 mm in depth and shall not weigh more than 34 kg.

2.3.2.2 Local Alarm Annunciation

The local processor shall provide local audible alarm annunciation for itself and its associated portals/zones and terminal devices. The local alarm annunciation feature shall be enabled and disabled from the central processor under operator control. This function shall be password protected.

2.3.2.3 Communications Protocol

The communications protocol shall be compatible between the local processor, its associated EECS terminal devices, and the central processor.

2.3.2.4 Terminal and Facility Interface Device Support

The local processor shall interface to the full range of EECS terminal and facility interface devices as shown.

2.3.2.5 Response Times

The local processor shall initiate a response to a central processor interrogation within 100 milliseconds. The local processor shall respond to valid passage requests from its associated EECS terminal devices by generating a signal to the appropriate electric strike or other type of facility interface device within 100 milliseconds after identifier verification.

2.3.2.6 Autonomous Local Control

In the event of a communication loss, the local processor shall automatically convert to autonomous local control and monitoring of its associated EECS terminal devices or facility interface devices. The local processor shall automatically revert to central control upon restoration of communications. System transactions occurring during the communications outage shall be recorded and retained in local processor memory and reported to the central database files upon restoration of communications. The local processor shall begin the report to the central database within 10 seconds after communications have been restored.

2.3.2.7 Local Processor Capacities

The local processor shall be able to control a combination of at least 4 electric door strikes, card readers, or other EECS terminal devices and facility interface devices. The local processor shall store a subset of the EECS reference file database sufficient to support access through each portal controlled by the local processor, and including personal, access authorization, and identifier data for each enrollee as needed to support passage requests. The local processor shall provide a local transaction history file with capacity to store at least the number of transactions

calculated for each portal controlled by the local processor or a minimum of 1000 transactions without losing any data.

2.3.2.8 Diagnostics

The local processor shall incorporate built-in diagnostics implemented in software/firmware, hardware or both. Each time the local processor is started it shall automatically execute a series of built-in tests, and report equipment malfunctions, configuration errors, and inaccuracies to the central processor. The EECS shall annunciate a fail-safe alarm if the local processor fails the built-in diagnostics. Diagnostic aids shall be provided within the local processor to aid in system set-up, maintenance, and troubleshooting.

2.3.2.9 Access Modes

Local processors shall be designed to allow any combination of terminal devices in any configuration as an access mode. The access modes shall be enabled and disabled for individual portals under the control of the system operator. A remote access mode shall be provided in which passage requests shall only be granted by an operator from the central console.

2.3.4 Color Graphics Monitor Display

The color graphic display shall consist of a microprocessor based color monitor with a minimum diagonal measurement of 310 mm (12 inches) and display at least eight colors. The unit shall have refresh memory with a screen refresh rate of at least 60 times per second, noninterlaced. The monitor shall have a minimum screen display of 1920 characters (24 lines with 80 characters each). The screen display shall have a minimum resolution of 640 by 350 pixels.

2.3.5 Keyboards

Keyboards shall be furnished for use with the monitor. As a minimum, the keyboard shall include a 96-character standard ASCII character set based on ANSI X3.154. The keyboard shall provide the man/machine interface to allow the operator to interact with EECS command and applications software.

2.3.6 Enhancement Hardware

Enhancement hardware such as special function keyboards, special function keys, light pens, touch screen devices, or mouse shall be provided if they are required to operate the system.

2.3.7 System Maintenance Hardware

Hardware recommended by the system manufacturer for performing system maintenance shall be provided.

2.4 SOFTWARE

Software shall be categorized as system software and application software. System software shall consist of software to support system setup, system operation, routine hard drive back-ups, and other maintenance routines. Application software shall consist of software to provide complete operation of the EECS. The Contractor shall provide software in modules to meet the requirements of the system to be installed at the site.

2.4.1 User Alteration

The design of processor assemblies shall preclude user-alteration of the integral firmware and shall preclude use of the processor assemblies for purposes other than the intended system, portal, and zone status monitoring, control, annunciation, and display.

2.4.2 System Software

System software including the operating system shall be complete off-the-shelf, modifiable for the site specific needs of the EECS. The system software shall be compatible with all system hardware and applications software. System software shall support the application programs. Each program shall be assigned a priority level. The priority levels shall be sufficient in number to provide total functional operation as specified. The standard system software supplied shall not be modified in any way that would preclude the purchase of a standard maintenance and service contract from the computer manufacturer.

2.4.2.1 Bootstrap Program

The software shall include a bootstrap loader program adequate to automatically initiate EECS operation when console equipment is powered up. The bootstrap loader program shall also load the central processor memory from the fixed hard disk system.

2.4.2.2 Disk Operating System

A currently available and supported disk operating system shall be utilized, including:

a. Program control functions including program loading, execution, and termination.

b. Error detection and recovery.

c. Device drivers shall be supplied as needed for operation of the keyboard, monitor, disk systems, and enhancement hardware.

d. File management including creation and deletion of files, searching, sequential and random file access, and maintenance of a file directory and subdirectories.

e. Disk management including drive selection, partitioning, space allocation and recovery, write verification, and a copy routine to transfer information between any two devices.

f. Diagnostic programs to check the status of the Operator's Console on its screen.

g. Maintain current date and time.

2.4.3 Disk Compress Software

Utility software shall be provided to recover file space lost to fragmentation by making files on the fixed hard disk and floppy disk archives as contiguous as possible.

2.4.4 Application Software

Application software shall be comprised of computer programs and computer databases as required. Application software shall be menu driven or command driven. The software programs provided shall not require modification to monitor and control the number of output relays and zones specified or shown. The manufacturer shall upgrade, update, revise, or otherwise modify software and firmware as required to incorporate manufacturer developed improvements or firmware options for a period of one year after installation.

2.4.4.1 Password Control

Any action which could compromise the security or integrity of the EECS shall be password controlled. A minimum of 3 password levels shall be provided.

2.4.4.2 Data Entry

Installation-related characteristics shall be user-entered by keyboard control operations prompted by display instructions for the operator. Entry of installation-related data shall not require specific computer training or knowledge of computer operation, computer languages, or programming procedures. Data entry shall neither require nor permit processor assembly or microprocessor programming or modification of the integral firmware.

2.4.4.3 Input Error Recovery

The system shall supervise operator inputs to ensure they are correct for proper execution. Operation 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 shall not require an operator to look up a code in a manual or other hardcopy document. Conditions for which operator error assistance messages shall be generated include but not be limited to:

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.

2.5 ELECTRONIC ENTRY CONTROL SYSTEM ALARMS

The EECS shall annunciate an alarm when the following conditions occur. All alarms shall be annunciated at the console both audibly and visually. The alarm annunciation shall continue until acknowledged by the system operator. Only one control key shall be needed to acknowledge an alarm. The EECS shall control, monitor, differentiate, rank, annunciate, and allow operators to acknowledge, in real time, alarm signals generated by EECS equipment. The EECS shall also provide a means to define and customize the annunciation of each alarm type. The EECS 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.

2.5.1 Local Processor Failure

The EECS shall continuously supervise local processor bus lines by monitoring the presence of communications with local processors and shall annunciate an alarm if a communications failure is detected.

2.5.2 Software Tamper

The EECS shall annunciate a tamper alarm when unauthorized changes to the EECS database files are attempted. Three consecutive unsuccessful attempts to log onto an EECS central processor 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 EECS application software shall maintain a transcript file of the last 5000 commands entered at each central processor to serve as an audit trail. The EECS shall not allow write access to the system transcript files by any person, regardless of their authorization level. The EECS shall only allow acknowledgment of software tamper alarms and read access to the EECS transcript files by operators and managers with the highest password authorization level available in the system.

2.5.3 Access Denial

The EECS shall annunciate an alarm when an attempt has been made to pass through a controlled portal and access has been denied.

2.5.4 Portal Open

The EECS shall annunciate an alarm when an access 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 from 1 second to 1 minute with a maximum resolution of 1 second.

2.5.5 Bolt Not Engaged

The EECS shall annunciate an alarm when the bolt at an access controlled portal has been open longer than a predefined time delay and generate an access control alarm. The time delay shall be adjustable, under operator control, over a range of at least from 1 second to 1 minute with a maximum resolution of 1 second.

2.5.6 Strike Not Secured

The EECS shall annunciate an alarm when the strike at an access controlled portal has been left unsecured longer than a predefined time delay and generate an access control alarm. The time delay shall be adjustable, under operator control, over a range of at least from 1 second to 1 minute with a maximum resolution of 1 second.

2.5.6.1 Graphics Linked to Alarms

The EECS shall relate graphics to alarms. Whenever one of the predefined alarms is annunciated on an EECS control terminal, the graphic related to the alarm shall be automatically displayed.

2.5.7 System Self-Test

The design of the EECS computer equipment shall provide for continuous internal program and data memory self test.

2.5.8 System Expansion Capability

The EECS central processor, associated hardware, and system and application software shall allow for a system expansion of at least 25% percent more portals. The additional portals shall include associated terminal and facility interface devices, local processors, and output relays. All EECS functions, response times, and throughput rates shall be maintained at all portals.

2.6 FIELD HARDWARE

2.6.1 Card Readers and Credential Cards

EECS card readers shall use unique coded data stored in or on a compatible credential card as an identifier. The card readers shall be proximity type, 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 passive proximity detection credential 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 EECS card readers. The Contractor shall include within the card's encoded data a nonduplicated unique facility identification code common to all EECS credential cards provided. Enrollment equipment to support local encoding of badges including cryptographic and other internal security checks shall be supplied. Cards, card readers, and enrollment equipment shall be compatible.

2.6.1.1 Proximity

Proximity card readers shall use passive proximity detection and shall not require contact with the proximity credential card for proper operation. Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number. The card reader shall read proximity cards in a range from 0 mm to at least 150 mm from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.

2.6.1.3 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.

2.6.1.4 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.

2.6.1.5 Card Reader Size and Weight

The card reader shall not be more than 255 m high by 255 m wide by 130 mm deep. The card reader shall not weigh more than 7 kg.

2.6.1.6 Card Reader Power

The card reader shall be powered from the source as shown and shall not dissipate more than 150 watts.

2.6.1.7 Card Reader Mounting Method

Card readers shall be suitable for surface, or semi-flush, or weatherproof mounting as required.

2.6.1.8 Credential Card Modification

EECS cards shall be able to be modified by lamination 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 badgeholder used at the site.

2.6.1.9 Card Size and Dimensional Stability

Credential cards shall be 54.0 by 85.7 mm (2-1/8 by 3-3/8 inches) The credential card material shall be dimensionally stable in the sense that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

2.6.1.10 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.

2.6.1.11 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. The Contractor shall provide a means to allow on-site assembly and lamination of credential cards by Government personnel.

2.6.1.12 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 wetted with a soap and water solution.

2.6.2 Keypads

EECS 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 ascending ASCII code ordinal sequence. Communications protocol shall be compatible

with the local processor.

2.6.2.1 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.

2.6.2.2 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.

2.6.2.3 Keypad Size and Weight

The keypad shall not be more than 255 mm (10 inches) high by 255 mm (10 inches) wide by 128 mm (5 inches) deep. The keypad shall not weigh more than 4.5 kg.

2.6.2.4 Keypad Power

The keypad shall be powered from the source as shown and shall not dissipate more than 150 watts.

2.6.2.5 Keypad Mounting Method

Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

2.6.2.6 Keypad Duress Codes

Keypads shall provide a means for users to indicate a duress situation by entering a special code. Upon receipt of the special duress code, the EECS shall annunciate a duress alarm.

2.6.3 Combination Card Reader and Keypad

The combination card reader and keypad shall comply with the individual requirements specified hereinbefore.

2.6.3 Enrollment Center Equipment

The Contractor shall provide enrollment equipment to enroll personnel into, and disenroll personnel from the EECS database. The enrollment equipment shall only be accessible to authorized EECS enrollment personnel. The Contractor shall provide enough credential cards for all 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 set-up and troubleshooting with the central processor(s).

2.6.4 Console Accessories

A steel desk-type console shall be provided. The console shall be as specified in EIA 310-D. A locking cabinet approximately 1.8 m high, 900 mm wide, and 600 mm deep with three adjustable shelves, and two storage

racks for storage of disks, manuals, and other documentation shall be provided.

2.6.5 Uninterruptible Power Supplies

2.6.5.1 Console Power Supply

All electrical and electronic equipment in the console shall be powered from an uninterruptible power supply . The uninterruptible power supply shall provide at least 4 hours battery back-up in the event of primary power failure. Batteries shall be sealed, non-outgassing type.

2.6.5.2 Local Processor Power Supply

Local processors and terminal devices shall be powered from an uninterruptible power source. The uninterruptible power source shall provide 4 hours battery back-up 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 during the switch from primary to battery power and vice versa. Batteries shall be sealed, non-outgassing type.

2.8 PORTAL CONTROL AND FACILITY INTERFACE

2.8.2 Electric Door Strikes/Bolts

Electric door strikes/bolts shall be designed to release automatically in case of power failure. These facility interface devices shall use DC power to energize the solenoids. Electric strikes/bolts shall incorporate end of line resistors to facilitate line supervision by the EECS.

2.8.2.1 Solenoid

The actuating solenoid for the strikes/bolts furnished shall not dissipate more than 12 watts and shall operate on 12 or 24 volts DC. The inrush current shall not exceed 1 ampere and the holding current shall not be greater than 500 milliamperes. The actuating solenoid shall move from the fully secure to fully open positions in not more than 500 milliseconds.

2.8.2.2 Signal Switches

The strikes/bolts shall include signal switches to indicate to the EECS when the bolt is not engaged or the strike mechanism is unlocked. The signal switches shall report a forced entry to the EECS.

2.8.2.3 Tamper Resistance

The electric strike/bolt mechanism shall be encased in hardened guard barriers to deter forced entry.

2.8.2.4 Size and Weight

Electric strikes/bolts shall be compatible with standard door frame preparations and shall not weigh more than 4.5 kg.

2.8.2.5 Mounting Method

The electric door strikes/bolts 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.

2.11 WIRE AND CABLE

2.11.1 General

The Contractor shall provide all wire and cable not indicated as GFE. All wiring shall meet NFPA 70 standards. Conduit shall be minimum 21mm.

2.11.2 Terminal Device Wiring

Terminal device wiring shall be shielded and as needed to match hardware. Multiconductor wire shall be at least 20 AWG and shall have an outer jacket of PVC.

2.11.3 Class 2 Low Energy Conductors

The conductor sizes specified for digital functions shall take precedence over any requirements for Class 2 low energy signal circuit conductors specified elsewhere.

2.14 PREDELIVERY TESTING

2.14.1 General

The Contractor shall assemble the test EECS as specified, and perform tests to demonstrate that the performance of the system satisfies the requirements of this specification in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment, and software and firmware 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 data acquired are correlated to allow logical interpretation.

2.14.2 Test Setup

The test setup shall be used to prove system functionality, system capacity, hardware interaction, and hardware and software interaction. The test setup shall demonstrate passage requirements, and EECS alarms and alarm reporting functions. Exclusive of personnel interaction time, the EECS shall provide verification or alarm within 2 seconds after data entry is completed at the portal terminal devices. System shall be tested under system heavy load conditions as described in paragraph "System Heavy Load Definition". The test setup shall include:

a. All console equipment.

b. At least one each type of DTM circuit and associated equipment used in the EECS.

c. The number of local processors required by the EECS site design.

d. At least one of each type of terminal device used.

e. At least one of each type of portal configuration with all

facility interface devices specified or shown.

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, ANSI C2 and as shown, and shall furnish all 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 EECS 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. All wiring, including low voltage wiring outside the security control console, cabinets, boxes, and similar enclosures, shall be installed in rigid galvanized steel conduit conforming to UL 6. Minimum size of conduit shall be 15 mm (1/2 inch). Connections shall be tight tapered threaded. No threadless fittings or couplings shall be used. Conduit outlet boxes, pull boxes, junction boxes, conduit fittings and similar enclosures shall be cast metal or malleable iron as specified in Sections(s) 16415 ELECTRICAL WORK, INTERIOR with threaded hubs or bodies. Electric metallic tubing (EMT), armored cable, nonmetallic sheathed cable, or flexible conduit will not be permitted except where specifically shown. DTM 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 herein. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

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/or brazing on factory galvanized boxes, enclosures, conduits, etc., shall be coated with a cold galvanized paint containing at least 95 per cent zinc by weight.

3.2 SYSTEM STARTUP

The Contractor shall not apply power to the EECS until after:

a. EECS equipment items and DTM have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the EECS has been conducted to insure 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 EECS 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 installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

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 must 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.

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SECTION 16760

INTERCOMMUNICATION SYSTEM

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	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(1992; Rev thru Nov 1994) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

The system shall be solid state, modular in design, and shall be of the wired type with a single master at each instructor station, and remote stations at each student area.

1.2.1 Sound Reproduction

The intercommunication system shall reproduce a signal at all receiving stations from a 40 dB minimum input signal referenced to a microphone sound pressure level (SPL) over the frequency range of 300 to 3300 Hz. The received signal shall have a dynamic range of 30 dB, adjustable at the receiving station. Unless otherwise specified SPL shall be 20 micro Paschal. The root-mean-square (rms) extraneous noise (e.g. hum) level introduced by the intercommunication system shall be at least 30dB below the nominal signal level. Distortion, including envelope delay, intermodulation, cross talk, and other nonlinear sources, shall not exceed 5 percent.

1.2.2 System Operation and Service Features

1.2.2.1 Control and Power Requirements

The system shall have a power switch and an associated pilot light for ON and OFF operations. A volume control at each station shall be used to regulate listening volume. System shall operate on 110-125 Vac, single phase, 60 Hz.

1.2.2.2 Call-In Indication

Master stations shall have a "call-in" switch to provide an audible and/or visual indication of incoming calls from remote stations. Individual visual indication shall identify calling station and status, and remain actuated until a call is answered by a master station.

1.2.2.3 Identification Plates

In addition to the manufacturer's standard identification plates, engraved laminated phenolic identification plates shall be provided for each component connection and terminal. Identification labels shall be 3-layer black on white on black, engraved to show white letters on a black background. Any warning or caution labels shall be 3-layered red on white on red, engraved to show white letters on red background. Control switches and knobs shall be clearly marked with their function and status. Identification strips for station selector switches shall be located to clearly identify remote and master stations and shall be protected by transparent plastic inserts.

1.2.2.4 Speaker/Handset Stations

At speaker/handset stations, lifting the handset shall automatically cut out the loudspeaker in the station and all conversation shall be carried through the handset.

1.2.2.5 Privacy Switch

A privacy switch shall be provided at each remote station. When in the ON position, the switch shall prevent any transmission of sound from the remote station. When in the OFF position, without further switch manipulation, the station shall respond to incoming calls upon voice activation from anywhere within a 6 m (20-foot) radius of station.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO..

After approval of detail drawings and not later than three months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment and component in the system. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Intercommunication System; GA..

Detail drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, catalog cuts, manufacturer's data, materials and equipment lists, and operational and general maintenance instructions. Detail drawings shall be submitted for the overall system and for each major component. Drawings shall illustrate how each item of equipment has been coordinated and will function properly in the system. Detail drawings shall include an overall system schematic indicating relationship of intercommunication units on one diagram and showing power source, system controls, impedance matches, plus number, size, and maximum lengths of interconnecting wires and indicate clearances

required for maintenance and operation.

SD-09 Reports

Test Plan and Procedures; FIO..

Test plan and procedures for the acceptance test shall explain in detail step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedures shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; FIO..

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria. Each test report shall include the final position of controls and operating mode of the system. The manufacturer, model number, and serial number of test equipment used in each test shall also be included.

SD-19 Operation and Maintenance Manuals

Intercommunication System; FIO..

Sixcomplete copies of operation manuals outlining the step-by-step procedures required for system start-up, operation and shutdown. The manuals shall include equipment layout and schematics of simplified wiring and control diagrams of the system as installed. Instructions shall include the manufacturer's name, model number, and a brief description of equipment and components, and their basic operating features.

Sixcomplete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or 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 MATERIALS

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that have been in satisfactory use 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.

2.1.2 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.3 Nameplates

Each major component of equipment shall have the manufacturer's name, model number, and serial number on a plate screwed to the equipment.

2.2 TYPE 1 SYSTEM

Direct connected keyed intercommunication system shall accommodate five stations in any combination of master stations and remote stations. Master and remote stations shall be provided in the quantities indicated. Each master station shall selectively communicate with any other master station and any remote station by actuation of an appropriate selector switch.

2.2.1 Master Station

Surface wall-mounted master stations shall as a minimum conform to the following specifications:

Capacity:	Accommodate four stations
Speaker Sensitivity:	Minimum of 40 dB

2.2.2 Intercommunication Amplifier

The system intercommunication amplifier shall as a minimum conform to the following specifications:

Output Power:	2 watts rms or greater
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-To-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 200 Hz to 10,000 Hz

2.2.3 Remote Station

Surface wall-mounted remote station shall have anodized aluminum faceplate with tamper proof mounting screws and galvanized steel backbox with "station call-in" capabilities. The remote station shall provide a speaker with a minimum sensitivity of 40 dB for speakers less than 200 mm in diameter and 45 dB for speakers 200 mm or greater. The remote station shall have a call announcement monitor lamp and recurring momentary tone.

2.2.4 All-Call Amplifier

All-call amplifier shall as a minimum conform to the following specifications:

Output Power:	Minimum of 0.5 watt rms for each station
Total Harmonic Distortion:	Less than 5 percent at rated output power with a load equivalent to the quantity of stations connected to it in all-call mode of operation
Signal-To-Noise Ratio:	60 dB or greater at rated output
Frequency Response:	Plus or minus 2 dB from 200 Hz to 10,000 Hz

2.3 SPEAKER ENCLOSURES

Speaker enclosures shall be compatible with the speakers specified and comply with UL 50.

2.4 TERMINALS

Terminals shall be solderless, tool-crimped pressure type.

2.5 COMMUNICATIONS WIRING

Type of signal and control circuit wire and number of conductors shall be provided as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system. Where required, cable shall be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70.

2.6 SURGE PROTECTION

Major components of the system such as Master Stations, Amplifiers, and Remote Stations, shall have a device, either internal or external, which shall provide protection against voltage spikes and current surges.

PART 3 EXECUTION

3.1 INSTALLATION

All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and as specified and shown. Units to be mounted outside or subject to inclement conditions shall be weatherproof or be mounted in weatherproof enclosures.

3.1.1 Signal and Control Circuits Wiring

Signal and control circuits shall be installed in accordance with NFPA 70 and as indicated.

3.1.2 Conduit, Cable Tray and Tubing Systems

Wiring shall be installed in electric metallic tubing as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

3.2 GROUNDING

The connection of interfacing components shall be accomplished through the use of transformers and the tying of interconnecting lines to a unit ground

bus at one end only. The ground and distribution ground buses shall be solid copper wire with insulating covering.

3.3 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct an acceptance test, using the approved test plan, to demonstrate that the equipment operates in accordance with specification requirements. The Contractor shall notify the Contracting Officer 30 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written approval of the test plans. 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 2 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 instructions, as well as the demonstration 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 --