

**AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT**

1. CONTRACT ID CODE \_\_\_\_\_ PAGE \_\_\_\_\_ OF \_\_\_\_\_ PAGES

2. AMENDMENT/MODIFICATION NO. _____		3. EFFECTIVE DATE _____	4. REQUISITION/PURCHASE REQ. NO. _____	5. PROJECT NO. <i>(If applicable)</i> _____
6. ISSUED BY _____	CODE _____	7. ADMINISTERED BY <i>(If other than Item 6)</i> _____		CODE _____

8. NAME AND ADDRESS OF CONTRACTOR <i>(No., street, county, State and ZIP Code)</i>          CODE _____ FACILITY CODE _____	(X)	9A. AMENDMENT OF SOLICIATION NO. _____
		9B. DATED <i>(SEE ITEM 11)</i> _____
		10A. MODIFICATION OF CONTRACT/ORDER NO. _____
		10B. DATED <i>(SEE ITEM 11)</i> _____

**11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS**

The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers  is extended,  is not extended. Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:  
 (a) By completing items 8 and 15, and returning \_\_\_\_\_ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment your desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)* \_\_\_\_\_**13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.**

CHECK ONE	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: <i>(Specify authority)</i> THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES <i>(such as changes in paying office, appropriation date, etc.)</i> SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER <i>(Specify type of modification and authority)</i>

**E. IMPORTANT:** Contractor  is not,  is required to sign this document and return \_\_\_\_\_ copies to the issuing office.14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)* \_\_\_\_\_

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER <i>(Type or print)</i>		16A. NAME AND TITLE OF CONTRACTING OFFICER <i>(Type or print)</i>	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA	16C. DATE SIGNED
<i>(Signature of person authorized to sign)</i>		<i>(Signature of Contracting Officer)</i>	

Item 14. Continued.

### CHANGES TO PROPOSAL RECEIPT DATE

1. Standard Form 1442, First Page, Item No. 13.A.- In the second line, change the receipt of proposal date from "24 JANUARY 2003" to "28 JANUARY 2003". Receipt of proposal time remains 4 pm local time.

### CHANGES TO SPECIFICATIONS

2. Replacement Sections. - Replace the following sections with the accompanying new sections of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003."

03413A	PRECAST ARCHITECTURAL CONCRETE
05400A	COLD-FORMED STEEL FRAMING
07416A	STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
08210	WOOD DOORS
09915	COLOR SCHEDULE
15400A	PLUMBING, GENERAL PURPOSE
15500A	PASSIVE DESICCANT COOLING SYSTEMS
15974	BUILDING AUTOMATION & CONTROL SYSTEMS FOR LACKLAND AFB

3. Section 09250. - Replace Section 09250 GYPSUM BOARD with the accompanying new section 09250 GYPSUM BOARD ASSEMBLIES, each page bearing the notation "ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003."

### CHANGES TO DRAWINGS

4. Replacement Drawings.- Replace the drawings listed below with the attached new drawings of the same number, bearing the notation "AM #0005":

A117_5.cal	Seq 59	A-117 COMMONS - FIRST FLOOR PLAN
A118_5.cal	Seq 60	A-118 COMMONS - SECOND FLOOR PLAN
A119_5.cal	Seq 61	A-119 COMMONS - THIRD FLOOR PLAN
A332_5.cal	Seq 74	A-332 WALL SECTIONS
A333_5.cal	Seq 75	A-333 WALL SECTIONS
A546_5.cal	Seq 87	A-546 PLAN DETIALS
A547_5.cal	Seq 88	A-547 PLAN DETIALS
A648_5.cal	Seq 89	A-648 ROOM FINISH SCHEDULE - COMMONS
A649_5.cal	Seq 90	A-649 ROOM FINISH SCHEDULE - WING AND TYPICAL LIVING UNITS
A651_5.cal	Seq 91	A-651 DOOR SCHEDULE - COMMONS
A653_5.cal	Seq 93	A-653 DOOR SCHEDULE - E./W. WING & DOOR DETAILS
A655_5.cal	Seq 95	A-655 ENLARGED WINDOW ELEVATIONS & DETAILS
A656_5.cal	Seq 96	A-656 WINDOW DETAILS
A657_5.cal	Seq 97	A-657 MISCELLANEOUS DETAILS
A658_5.cal	Seq 98	A-658 MISCELLANEOUS DETAILS
SN01_5.cal	Seq 101	SN-01 STRUCTURAL NOTES AND DETAILS
S125_5.cal	Seq 126	S-125 COMMONS - FOUNDATION PLAN
S543_5.cal	Seq 144	S-543 PRE-CAST CONCRETE DETAILS
M002_5.cal	Seq 149	M-002 MECHANICAL SCHEDULES
E116_5.cal	Seq 203	E-116 COMMONS FIRST FLOOR RECEPTACLE PLAN
E125_5.cal	Seq 212	E-125 W. WING FIRST FLOOR SPECIAL SYSTEMS PLAN
E128_5.cal	Seq 215	E-128 COMMONS FIRST FLOOR SPECIAL SYSTEMS PLAN
E130_5.cal	Seq 217	E-130 COMMONS THIRD FLOOR SPECIAL SYSTEMS PLAN
E431_5.cal	Seq 218	E-431 ENLARGED TYPICAL LIVING UNIT FLOOR PLAN - ELECTRICAL
E636_5.cal	Seq 223	E-636 ELECTRICAL POWER RISER DIAGRAMS

END OF AMENDMENT

END OF AMENDMENT

## SECTION 03413A

## PRECAST ARCHITECTURAL 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.

## ACI INTERNATIONAL (ACI)

- |              |   |
|--------------|---|
| ACI 211.1    | (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| ACI 211.2    | (1998) Standard Practice for Selecting Proportions for Structural Lightweight Concrete        |
| ACI SP-66    | (1994) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement          |
| ACI 318/318R | (1995) Building Code Requirements for Structural Concrete and Commentary                      |
| ACI 318M     | (1995) Metric Building Code Requirements for Structural Concrete and Commentary               |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |                   |   |
|-------------------|---|
| ASTM A 416/A 416M | (1997) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete |
| ASTM C 494        | (1998) Chemical Admixtures for Concrete                           |
| ASTM C 1017       | (1997) Chemical Admixtures for Use in Producing Flowing Concrete  |

## AMERICAN WELDING SOCIETY (AWS)

- |          |  |
|----------|--|
| AWS D1.1 | (1998) Structured Welding Code - Steel |
|----------|--|

## PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

- |             |  |
|-------------|--|
| PCI MNL-116 | (1985) Manual for Quality Control for Plants and Production of Precast and |
|-------------|--|

## Prestressed Concrete Products

PCI MNL-117 (1996) Manual for Quality Control for  
Plants and Production of Architectural  
Precast Concrete Products

PCI MNL-122 (1989) Architectural Precast Concrete

## 1.2 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer certified under the PCI Plant Certification Program. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. Precast work shall be coordinated with the work of other trades.

## 1.3 SUBMITTALS

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

## SD-02 Shop Drawings

## Architectural Concrete System; G

Detail drawings showing details in accordance with ACI SP-66 and ACI 318M, including installation details. Detail drawings shall indicate separate identification marks for each different precast unit, location of units in the work, elevations, fabrication details, welding details, reinforcement, connections, dimensions, interface with adjacent members, blocking points for units stored at the precast concrete plant or at the jobsite, lifting points and special handling instructions in sufficient detail to cover manufacture, handling, and erection.

## SD-03 Product Data

## Calculations; G

Design calculations, prior to the manufacture of any precast architectural concrete units for the project.

## Mix Design; G

A statement giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, prior to commencing operations. The statement shall be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will

produce concrete of the properties required. No substitutions shall be made without additional tests to verify that the concrete properties are satisfactory.

#### Manufacturer's Qualifications

A statement giving the qualifications of the precast concrete manufacturer and of the installers, prior to commencing operations.

#### SD-04 Samples

##### Precast Concrete Units; G

A full-size mock-up, maintained at a location approved by the Contracting Officer until approval by the Contracting Officer for removal or incorporating in the project. The mock-up shall be used to establish quality and acceptance of precast units to be used on the project, and shall consist of three or more units, showing the exterior finish (matrix color, surface color, surface texture), panel back finish, edge treatment, joint treatment, all surface features, reinforcement, anchorage insert, lifting inserts, and other accessories. Mockup shall also include typical joints, including exterior corner joints and joints between units.

#### SD-06 Test Reports

##### Materials

Certified copies of test reports including all test data and all test results. Tests for compressive strength of concrete shall be performed by an approved independent commercial testing laboratory, except that compressive strength tests for initial prestress may be performed in the manufacturer's plant laboratory.

### 1.4 DESIGN

#### 1.4.1 Standards and Loads

Precast unit design shall conform to ACI 318M and PCI MNL-122. Design loads for precast concrete shall be as indicated on the drawings. A differential temperature of 24 degrees C, between interior and exterior faces of the units, shall be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection shall be accounted for in the design.

#### 1.4.2 Connections

Connection of units to other members, or to other units shall be of the type and configuration indicated. The design and sizing of connections for all design loads shall be by the Contractor.

#### 1.4.3 Concrete Strength

Precast concrete units shall have a 28-day compressive strength of 34 MPa .

#### 1.4.4 Concrete Proportion

Selection of proportions for concrete shall be based on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. The concrete proportion shall be developed using the same type and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Calcium chloride shall not be used in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive shall not be used in prestressed concrete.

#### 1.4.5 Calculations

Calculations for design of members and connections not shown shall be made by a professional engineer experienced in the design of precast architectural concrete. Calculation shall include the analysis of member for lifting stresses and the sizing of the lifting inserts.

#### 1.5 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Precast units temporarily stored at the manufacturer's plant shall be protected from damage in accordance with PCI MNL-117 and PCI MNL-122. Immediately prior to shipment to the jobsite, all precast concrete units shall be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality shall include, but shall not necessarily be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. All defective precast concrete units shall be replaced or repaired as approved.

#### 1.6 HANDLING AND STORAGE

Precast units shall be delivered to the site in accordance with delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite all precast units shall be inspected for quality as specified above. If the precast units cannot be unloaded and placed directly into the work, they shall be stored onsite, off the ground and protected from weather, marring, or overload. Precast units shall be handled in accordance with manufacturer's instructions.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Except as otherwise specified, material shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and Section 03200 CONCRETE REINFORCEMENT.

##### 2.1.1 Reinforcing Steel

Reinforcing steel shall be galvanized if clearance to an exterior face is 25 mm or less.

### 2.1.2 Prestressing Strands

Prestressing strands shall conform to ASTM A 416/A 416M.

### 2.1.3 Tie Wire

Tie wire shall be soft monel or 18-8 stainless steel.

### 2.1.4 Inserts

Inserts shall be manufacturer's standard, suited for the application.

### 2.1.5 Plates, Angles, Anchors and Embedments

Material shall be as specified in PCI MNL-117. Steel items, other than stainless, shall be coated with a rust-inhibiting paint or shall be hot-dip galvanized. Steel items, including items embedded in concrete, shall be either stainless steel or hot dip galvanized steel.

### 2.1.6 Form Release Agent

Release agent shall be manufacturer's standard nonstaining type.

### 2.1.7 Admixtures

Admixtures shall conform to ASTM C 494. Plasticizing admixture, if used, shall conform to ASTM C 1017.

## 2.2 PRECAST CONCRETE UNITS

Precast concrete units shall be manufactured and cured in accordance with the applicable provisions of PCI MNL-116 and PCI MNL-117. Units shall be manufactured within the allowable tolerances given in PCI MNL-117 and PCI MNL-122.

### 2.2.1 Formwork

Forms shall be steel of adequate thickness, braced, stiffened, anchored and aligned to produce precast architectural concrete units within required dimensional tolerances. Forms shall be sufficiently rigid to provide dimensional stability during handling and concrete placement and consolidation. Fiberglass-reinforced plastic, plastic coated wood, elastomeric or other nonabsorptive material shall be used for making tight joints and rustication pieces.

### 2.2.2 Reinforcement

Fabrication and placement of reinforcement shall conform to the details shown on the approved detail drawings and PCI MNL-116 and PCI MNL-117.

### 2.2.3 Embedded Accessories

Anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units shall be furnished and installed in

accordance with the approved detail drawings. Embedded items shall be accurately positioned in their designed location, and shall have sufficient anchorage and embedment to satisfy design requirements.

#### 2.2.4 Stripping

Precast concrete units shall not be removed from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

#### 2.2.5 Identification

Each precast concrete unit shall be marked to correspond to the identification marks for each different precast unit shown on the detail drawings.

#### 2.2.6 Finishes

##### 2.2.6.1 Exposed Surfaces

Surfaces of precast units exposed to view or surfaces indicated to be finished shall be finished as follows: [AM0005] Smooth formed finish to receive applied coating specified in Section 09900.

##### 2.2.6.2 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished shall be finished in accordance with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### PART 3 EXECUTION

#### 3.1 ERECTION

Precast units shall be erected in accordance with the detail drawings and without damage to other units or to adjacent members. Units shall be set true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances shall be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges shall be placed as required to maintain correct alignment. After final attachment, precast units shall be grouted as shown. After erection, welds and abraded surfaces of steel shall be cleaned and touched-up with a zinc-rich paint. Welds shall be made by a certified welder in accordance with the manufacturer's erection drawings. Pickup points, boxouts, inserts, and similar items shall be finished to match adjacent areas after erection. Erection of precast units shall be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders shall be in accordance with AWS D1.1.

#### 3.2 JOINT SEALING

Joint sealing shall be as specified in Section 07900 JOINT SEALING.

### 3.3 CLEANING

Not sooner than 72 hours after joints are sealed, faces and other exposed surfaces of precast concrete discolored during erection shall be cleaned to remove dirt and stains by dry scrubbing with a stiff fiber brush, wetting the surface and vigorous scrubbing of the finish with a stiff fiber brush followed by additional washing, or by chemical cleaning compounds such as detergents or other commercial cleaners. Commercial cleaners shall be used in accordance with the manufacturer's recommendations. Cleaning procedure shall be performed on a designated test area and shall be approved prior to proceeding with cleaning work. Discolorations which cannot be removed by these procedures, will be considered defective work. Cleaning work shall be done when temperature and humidity permit surfaces to dry rapidly. Adjacent surfaces shall not be damaged during cleaning operations.

### 3.4 PROTECTION OF WORK

Precast units shall be protected against damage from subsequent operations.

### 3.5 DEFECTIVE WORK

Precast concrete units damaged during erection shall be repaired as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units shall match the adjacent surfaces in color and texture and shall be as approved. Unless otherwise approved, repair procedures shall conform to PCI MNL-116 and PCI MNL-117.

-- End of Section --

## SECTION 05400A

## COLD-FORMED STEEL 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 Cold-Formed Spec (1996) Specification & Commentary for the Design of Cold-Formed Steel Structural Members (Part V of the Cold-Formed Steel Design Manual)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2001) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 370 (1997a) Mechanical Testing of Steel Products

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B 633 (1985; R 1998) Electrodeposited Coatings of Zinc on Iron and Steel

ASTM C 955 (2000a) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

ASTM E 329 (2000b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.3 (1998) Structural Welding Code - Sheet Steel

## SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 78

(1998) Steel Self Drilling Tapping Screws

## 1.2 SUBMITTALS

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

## SD-02 Shop Drawings

Framing Components; G, ED

a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

## SD-07 Certificates

Mill Certificates; G, RE

Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E 329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A 370.

Welds; G, RE

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3.

## 1.3 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered and handled preventing bending or other damage, and avoiding contact with soil or other contaminating materials. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust.

## PART 2 PRODUCTS

## 2.1 STEEL STUDS, TRACKS, BRACING, BRIDGING, AND ACCESSORIES

Framing components shall comply with ASTM C 955 and the following:

a. Material shall be corrosion-resistant steel complying with ASTM A 653/A 653M, Grade 230 or higher, having a minimum yield of 230 MPa and a G 60 minimum zinc coating.

b. Minimum uncoated steel thickness (design thickness times 0.95):

(1). Purlins, bracing and bridging: Thickness as shown on the drawings.

(2). Accessories: Standard thickness as provided by the manufacturer.

[AM0005] (3). Exterior wall studs shall have a minimum thickness of 2.2mm (16ga).

(4). Interior wall studs shall have a minimum thickness as given in Specification Section 09250.

c. Purlin stud effective section properties as shown on the drawings:

## 2.2 MARKINGS

Purlins shall have product markings on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 1200 mm on center and shall be legible and easily read. The product marking shall include the following:

a. Manufacturer's identification.

b. Minimum delivered uncoated steel thickness.

c. Protective coating designator.

d. Minimum yield strength.

## 2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling tapping in compliance with SAE J 78 of the type, size, and location as shown on the drawings. Electroplated screws shall have a Type II coating in accordance with ASTM B 633. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M as appropriate. Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A 123/A 123Mor ASTM A 153/A 153M as appropriate.

## PART 3 EXECUTION

### 3.1 Delivery, Handling and Storage

a. Materials shall be delivered and handled in a manner to avoid bending or other damage and to avoid contact with the soil or other contaminating materials.

b. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content galvanizing repair paint whenever necessary to prevent the formation of rust.

### 3.2 CONNECTIONS

#### 3.2.1 Welds

All welding shall be performed in accordance with AWS D1.3, as modified by AISI Cold-Formed Spec. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3. All welds shall be cleaned and coated with rust inhibitive galvanizing paint.

#### 3.2.2 Screws

Screws shall be of the self-drilling self-tapping type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI Cold-Formed Spec. Screws covered by sheathing materials shall have low profile heads.

#### 3.2.3 Anchors

Anchors shall be of the type, size, and location shown on the drawings.

### 3.3 INSTALLATION

#### 3.3.1 General Requirements

- a. Prefabricated frames shall be square, with components attached to prevent racking during fabrication, transportation, and lifting. Design and construction of frames shall include provisions for lifting.
- b. Cutting of steel framing shall be by saw, shear, or plasma cutting equipment. Oxyacetylene torch cutting is not permitted.
- c. Temporary bracing shall be provided and remain in place until work is permanently stabilized.
- d. Abutting lengths of track shall be butt-welded, spliced, or each length securely anchored to a common structural element. Track shall be securely anchored to the supporting structure as shown on the drawings.
- e. Splicing of framing components, other than track and tension members, is not permitted.
- f. Wire tying of framing members is not permitted.

3.3.2 Purlins

- a. Purlins shall be spaced as shown on the drawings.
- b. Web stiffeners at support locations and at points of concentrated loads shall be provided as shown on the drawings.
- c. Bridging, of the type and spacing shown on the drawings, shall be installed prior to loading.
- d. Additional framing around openings shall be provided as shown on the drawings when the width of the opening exceeds the typical joist spacing.

-- End of Section --

## SECTION 07416A

## STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) 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.

## ALUMINUM ASSOCIATION (AA)

AA Design Manual (2000) Aluminum Design Manual:  
Specification & Guidelines for Aluminum  
Structures

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec S335 (1989) Specification for Structural Steel  
Buildings - Allowable Stress Design,  
Plastic Design

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI Cold-Formed Mnl (1996) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M (2000) Steel Sheet, Aluminum-Coated, by  
the Hot-Dip Process

ASTM A 653/A 653M (2000) Steel Sheet, Zinc-Coated  
(Galvanized) or Zinc-Iron Alloy-Coated  
(Galvannealed) by the Hot-Dip Process

ASTM A 792/A 792M (1999) Steel Sheet, 55% Aluminum-Zinc  
Alloy-Coated by the Hot-Dip Process

ASTM B 209 (2000) Aluminum and Aluminum-Alloy Sheet  
and Plate

ASTM B 209M (2000) Aluminum and Aluminum-Alloy Sheet  
and Plate (Metric)

ASTM C 1177/C 1177M (1999) Glass Mat Gypsum Substrate for Use  
as Sheathing

ASTM C 1289 (1998) Faced Rigid Cellular  
Polyisocyanurate Thermal Insulation Board

ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 1999el) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1999) Specular Gloss
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994el) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM E 1592	(1998) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000) Water Vapor Transmission of Materials
ASTM G 154	(2000ael) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

## AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1998) Minimum Design Loads for Buildings and Other Structures
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## STEEL JOIST INSTITUTE (SJI)

SJI Specs & Tables	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders
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## 1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies all requirements contained herein and has been verified by load testing and independent design analyses to meet the specified design requirements.

## 1.2.1 Structural Standing Seam Metal Roof (SSSMR) System

The SSSMR system covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

## 1.2.2 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing and designing SSSMR systems for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

## 1.2.3 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

### 1.3 DESIGN REQUIREMENTS

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

#### 1.3.1 Design Criteria

Design criteria shall be in accordance with ASCE 7.

#### 1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

#### 1.3.3 Live Loads

##### 1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 1335 N concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

##### 1.3.3.2 Uniform Loads

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of 960 Pa.

#### 1.3.4 Roof Snow Loads

The design roof snow loads shall be as shown on the contract drawings.

#### 1.3.5 Wind Loads

The design wind uplift pressure for the roof system shall be as shown on the contract drawings. The design uplift force for each connection assembly shall be that pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

- a. Single fastener in each connection.....3.0
- b. Two or more fasteners in each connection...2.25

#### 1.3.6 Thermal Loads

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of 116 degrees C during the life of the structure.

#### 1.3.7 Framing Members Supporting the SSSMR System

Any additions/revisions to framing members supporting the SSSMR system to accommodate the manufacturer/fabricator's design shall be the Contractor's responsibility and shall be submitted for review and approval. New or revised framing members and their connections shall be designed in accordance with AISC ASD Spec S335, AISI Cold-Formed Mnl, and SJI Specs & Tables, as applicable. Maximum deflection under applied live load, snow, or wind load shall not exceed 1/180 of the span length.

#### 1.3.8 Roof Panels Design

Steel panels shall be designed in accordance with AISI Cold-Formed Mnl. Aluminum panels shall be designed in accordance with AA Design Manual. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports. Deflection shall be calculated and measured along the major ribs of the panels.

#### 1.3.9 Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 9 mm will be allowed when the supporting structural members are prepunched or predrilled.

#### 1.4 PERFORMANCE REQUIREMENTS

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 750 mm. Test 2 shall simulate the interior condition with both ends free of crosswise restraint. The maximum span length for the interior condition shall be 1.5 m . External

reinforcement, such as clamps on the ribs, shall not be installed to improve uplift resistance. Bolts through seams shall not be installed.

#### 1.5 SUBMITTALS

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

##### SD-02 Drawings

Structural Standing Seam Metal Roof System; G.

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

##### SD-03 Product Data

Design Analysis; G.

Design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis shall include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and shall indicate how expected thermal movements are accommodated.

Qualifications.

Qualifications of the manufacturer and installer.

##### SD-04 Samples

Accessories.

One sample of each type of flashing, trim, closure, thermal spacer block, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels.

One piece of each type to be used, 225 mm long, full width.

Factory Color Finish; G.

Three 75 by 125 mm samples of each type and color.

Fasteners.

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation.

One piece, 300 by 300 mm, of each type and thickness to be used, with a label indicating the rated permeance (if faced) and R-values. The flame spread, and smoke developed rating shall be shown on the label or provided in a letter of certification.

Gaskets and Insulating Compounds.

Two samples of each type to be used and descriptive data.

Sealant.

One sample, approximately 0.5 kg, and descriptive data.

Concealed Anchor Clips.

Two samples of each type used.

Subpurlins.

One piece, 225 mm long.

EPDM Rubber Boots.

One piece of each type.

#### SD-06 Test Reports

Test Report for Uplift Resistance of the SSSMR; G.

The report shall include the following information:

- a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.
- b. Details of the anchor clip, dimensions, and thickness.
- c. Type of fasteners, size, and the number required for each connection.

- d. Purlins/subpurlins size and spacing used in the test.
- e. Description of the seaming operation including equipment used.
- f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.
- g. Any additional information required to identify the SSSMR system tested.
- h. Signature and seal of an independent registered engineer who witnessed the test.

#### SD-07 Certificates

##### Structural Standing Seam Metal Roof System.

- a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.
- b. Certification that materials used in the installation are mill certified.
- c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.
- d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.
- e. Certification of installer. Installer certification shall be furnished.
- f. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties, and the manufacturer's 20-year system weathertightness warranty.

##### Insulation.

Certificate attesting that the polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

#### 1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

#### 1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

##### 1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, and skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

##### 1.7.2 Manufacturer's Material Warranties.

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

c. A roofing system manufacturer's 20 year system weathertightness warranty.

#### 1.8 COORDINATION MEETING

A coordination meeting shall be held 30 days prior to the first submittal, for mutual understanding of the Structural Standing Seam Metal Roof (SSSMR) System contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roof system manufacturer, the roofing supplier, the erector, the SSSMR design engineer of record, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

### PART 2 PRODUCTS

#### 2.1 ROOF PANELS

Panels shall be steel and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 9 m. When length of run exceeds 9 m and panel laps are provided, each sheet in the run shall extend over three or more supports. Sheets longer than 30 m may be furnished if approved by the Contracting Officer. Width of sheets shall provide not more than 600 mm of coverage in place. SSSMR system with roofing panels greater than 300 mm in width shall have standing seams rolled during installation by an electrically driven seaming machine. Height of standing seams shall be not less than 37 mm for rolled seam and 50 mm for seams that are not rolled.

##### 2.1.1 Steel Panels

Steel panels shall be zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2,

coating designation T2 65. Zinc, zinc-aluminum alloy or aluminum coated panels shall be 0.584 mm thick minimum. Panels shall be within 95 percent of reported tested thickness as noted in wind uplift resistance testing required in paragraph PERFORMANCE REQUIREMENTS. Prior to shipment, mill finish panels shall be treated with a passivating chemical to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

## 2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system. Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

## 2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water. The use of a continuous angle butted to the panel ends to form a closure will not be allowed.

### 2.3.1 [AM0005] Soffit and Fascia Panels

Soffit and fascia panels shall be manufacturer's standard flat panel design nominal 25 mm overall depth formed from same sheet material as roofing panels.

## 2.4 FASTENERS

Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 3340 N per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 10 mm for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm thick. Exposed fasteners for factory color finished panels shall be factory finished to match the color of the panels.

### 2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14. Actual

screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

#### 2.4.2 Bolts

Bolts shall be not less than 6 mm diameter, shouldered or plain shank as required, with locking washers and nuts.

#### 2.4.3 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 6 mm diameter. Blind (pop) rivets shall be not less than 7 mm minimum diameter.

#### 2.5 SUBPURLINS

Cold formed supporting structural members/subpurlins shall have a minimum thickness of 1.5 mm and a minimum tensile yield strength of 345 MPa. Hot rolled structural members shall have a minimum thickness of 6 mm and a minimum tensile yield strength of 248 MPa. Subpurlins shall be galvanized .

#### 2.6 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated on the drawings or in Section 09915 COLOR SCHEDULE. The exterior coating shall be a nominal 0.025 mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than 0.005 mm thickness. The interior color finish shall consist of a 0.005 mm thick prime coat. The exterior color finish shall meet the test requirements specified below.

##### 2.6.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 2.0 to 3.0 mm failure at scribe, as determined by ASTM D 1654.

##### 2.6.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

##### 2.6.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM G 154. The coating shall withstand the weathering test without cracking, peeling,

blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating with an adhesion rating less than 4B when tested in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244.

#### 2.6.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

#### 2.6.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, with no cracking.

#### 2.6.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

#### 2.6.7 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

### 2.7 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 75 and a smoke developed rating not in excess of 150 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. Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

#### 2.7.1 Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck

Polyisocyanurate insulation shall conform to ASTM C 1289, Type II, (having

a minimum recovered material content of 10 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate (Ex: aluminum foil), the maximum design R-value per 25 mm of insulation used shall be 1.27. Facings shall be non-asphaltic, glass fiber reinforced.

#### 2.7.2 [AM0005]Slip Sheet

Slip sheet shall be an inorganic vapor barrier product acceptable to the manufacturer of the standing seam metal roof panels. Complying example is "Tyvek".

#### 2.8 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

#### 2.9 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

#### 2.10 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

#### 2.11 PREFABRICATED CURBS AND EQUIPMENT SUPPORTS

Prefabricated curbs and equipment supports shall be of structural quality, hot-dipped galvanized or galvanized sheet steel, factory primed and prepared for painting with mitered and welded joints. Integral base plates and water diverter crickets shall be provided. Minimum height of curb shall be 200 mm above finish roof. Curbs shall be constructed to match roof slope and to provide a level top surface for mounting of equipment. Curb flange shall be constructed to match configuration of roof panels. Curb size shall be coordinated, prior to curb fabrication, with the mechanical equipment to be supported. Strength requirements for equipment supports shall be coordinated to include all anticipated loads. Flashings shall not be rigidly attached to underline structure.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible

when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

#### 3.1.1 Field Forming of Panels for Unique Area

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

#### 3.1.2 Subpurlins

Unless otherwise shown, subpurlins shall be anchored to the joists or other structural framing members with bolts or screws. Attachment to the substrate (when provided) or to the panels is not permitted. The subpurlin spacing shall not exceed 750 mm on centers at the corner, edge and ridge zones, and 1500 mm maximum on centers for the remainder of the roof. Corner, edge, and ridge zones are as defined in ASCE 7.

#### 3.1.3 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings.

#### 3.1.4 Concealed Anchor Clips

Concealed anchor clips shall be fastened directly to the subpurlins or structural framing members. Attachment to the substrate (when provided) or to the metal deck is not permitted. The maximum distance, parallel to the

seams, between clips shall be 750 mm on center at the corner, edge, and ridge zones, and 1500 mm maximum on centers for the remainder of the roof.

### 3.2 INSULATION INSTALLATION

Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation with vapor retarder providing equivalent R-value and perm rating as remaining insulation. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

#### 3.2.1 Board Insulation with Blanket Insulation

Rigid or semirigid board insulation shall be laid in close contact. Board shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, and shall have a minimum of 1 fastener per 0.37 square meters. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer.

### 3.3 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

FACILITY DESCRIPTION \_\_\_\_\_

BUILDING NUMBER: \_\_\_\_\_

CORPS OF ENGINEERS CONTRACT NUMBER: \_\_\_\_\_

CONTRACTOR

CONTRACTOR: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

OWNER

OWNER: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONSTRUCTION AGENT

CONSTRUCTION AGENT: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

POINT OF CONTACT: \_\_\_\_\_

TELEPHONE NUMBER: \_\_\_\_\_

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY \_\_\_\_\_ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON \_\_\_\_\_ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

\_\_\_\_\_  
(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).
2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.
3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.
4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.
5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.
6. THIS WARRANTY APPLIES TO THE SSSMR SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.
7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

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CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM  
(continued)

\*\*REPORTS OF LEAKS AND SSSMR SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

## SECTION 08210

## WOOD DOORS

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 90	(1997) Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E 152	(1981; Rev. A) Fire Tests of Door Assemblies
ASTM E 283	(1991) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

## ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI Qual Stds	(1997) Architectural Woodwork Quality Standards and Quality Certification Program
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## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(1995) High-Pressure Decorative Laminates
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) Fire Doors and Fire Windows
NFPA 252	(1995) Fire Tests of Door Assemblies

## WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

NWWDA I.S. 1-A	(1993) Architectural Wood Flush Doors
NWWDA I.S. 4	(1994) Water-Repellent Preservative Non-Pressure Treatment for Millwork
NWWDA I.S. 6	(1991) Wood Stile and Rail Doors
NWWDA TM-5	(1990) Split Resistance Test

NWWDA TM-7 (1990) Cycle - Slam Test

NWWDA TM-8 (1990) Hinge Loading Resistance Test

UNDERWRITERS LABORATORIES (UL)

UL 10B (1997) Fire Tests of Door Assemblies

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

### SD-02 Shop Drawings

Doors; G

Submit drawings or catalog data showing each type of door unit . Drawings and data shall indicate door type and construction, sizes, thickness, and glazing,.

### SD-03 Product Data

Doors; G

Accessories

Water-resistant sealer

Sample warranty

Fire resistance rating; G

### SD-04 Samples

Door finish colors; G

Submit a minimum of three color selection samples .

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 100 mm thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Do not store in a building under construction until concrete, masonry work, and plaster are dry. Replace defective or damaged doors with new ones.

## 1.4 WARRANTY

Warranty shall warrant doors free of defects as set forth in the door

manufacturer's standard door warranty.

## PART 2 PRODUCTS

### 2.1 DOORS

Provide doors of the types, sizes, and designs indicated .

#### 2.1.1 Flush Doors

Flush doors shall conform to NWWDA I.S. 1-A. Stile edge bands of doors to receive natural finish shall be hardwood, compatible with face veneer. Stile edge bands of doors to be painted shall be mill option specie. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware.

##### 2.1.1.1 Interior Flush Doors

Provide particleboard core, Type II flush doors conforming to NWWDA I.S. 1-A with faces of plastic laminate. . Finish plastic laminate faced doors on both vertical edges with wood of color matching faces.

#### 2.1.2 Fire Doors

Doors specified or indicated to have a fire resistance rating shall conform to the requirements of UL 10B, ASTM E 152, or NFPA 252 for the class of door indicated. Affix a permanent metal label with raised or incised markings indicating testing agency's name and approved hourly fire rating to hinge edge of each door.

## 2.2 ACCESSORIES

### 2.2.1 Door Light Openings

Provide glazed openings with the manufacturer's standard moldings. Moldings for flush doors shall be lip type. Provide glazed openings in fire-rated doors with fire rated frames. Glazing is specified in Section 08800N, "Glazing."

### 2.2.2 Additional Hardware Reinforcement

Provide fire rated doors with hardware reinforcement blocking. Size of lock blocks shall be as required to secure the hardware specified. Top, bottom and intermediate rail blocks shall measure 125 mm minimum by full core width. Reinforcement blocking shall be in compliance with the manufacturer's labeling requirements and shall not be mineral material similar to the core.

## 2.3 FABRICATION

### 2.3.1 Marking

Each door shall bear a stamp, brand, or other identifying mark indicating quality and construction of the door.

### 2.3.2 Quality and Construction

Identify the standard on which the construction of the door was based and identify doors having a Type I glue bond.

### 2.3.3 Adhesives and Bonds

NWWDA I.S. 1-A. Use Type I bond for exterior doors and Type II bond for interior doors. Adhesive for doors to receive a natural finish shall be nonstaining.

### 2.3.4 Prefitting

At the Contractor's option, doors may be provided factory pre-fit. Doors shall be sized and machined at the factory by the door manufacturer in accordance with the standards under which they are produced. The work shall include sizing, bevelling edges, mortising, and drilling for hardware and providing necessary beaded openings for glass and louvers. Provide the door manufacturer with the necessary hardware samples, and frame and hardware schedules as required to coordinate the work.

### 2.3.5 Finishes

#### 2.3.5.1 Plastic Laminate Finish

Factory applied, NEMA LD 3, General or Specific purpose type, 1.25 mm minimum thickness. Glue laminated plastic for [AM0005] ~~solid~~~~hollow~~ core doors to wood veneer, plywood, or hardboard backing to form door panel. Combined minimum thickness of laminate sheet and backing shall be 2.5 mm.

#### 2.3.5.2 Color

Provide door finish colors as indicated .

### 2.4 SOURCE QUALITY CONTROL

Stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges shall meet the following performance criteria:

- a. Split resistance: Average of ten test samples shall be not less than 225 kilograms load when tested in accordance with NWWDA TM-5.
- b. Cycle-slam: 200,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of NWWDA TM-7.
- c. Hinge loading resistance: Average of ten test samples shall be not less than 315 kilograms load when tested for direct screw withdrawal in accordance with NWWDA TM-8 using a No. 12, 30 mm long, steel, fully threaded wood screw. Drill 4 mm pilot hole, use 40 mm opening around screw for bearing surface, and engage screw full, except for last 3 mm. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 2 mm minimum, 3 mm maximum clearance at sides and top, and a 5 mm minimum, 6 mm maximum clearance over thresholds. Provide 10 mm minimum, 11 mm maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 3 mm in 50 mm. Door warp shall not exceed 6 mm when measured in accordance with NWWDA I.S. 1-A.

3.1.1 Fire Doors

Install fire doors in accordance with NFPA 80. Do not paint over labels.

3.2 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

<u>PRODUCTS</u>	<u>INCH-POUND</u>	<u>METRIC</u>
Closet doors	1 1/8 inches	28.5 mm
	1 3/8 inches	35 mm
X-Ray resistant doors	1 3/4 inches	44.5 mm
	2 inches	50 mm
	2 1/4 inches	57 mm
	2 1/2 inches	64 mm
Weatherstripping	0.0089 inch	0.23 mm
	0.0063 inch	0.16 mm

-- End of Section --

## SECTION 09250

## GYPSUM BOARD[AM0005] ASSEMBLIES

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI A108.11 (1992) Interior Installation of  
Cementitious Backer Units
- ANSI A118.9 (1992) Cementitious Backer Units

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 36/C 36M (1999) Gypsum Wallboard
- ASTM C 79/C 79M (2001) Standard Specification for Treated  
Core and Nontreated Core Gypsum Sheathing  
Board
- ASTM C 442/C 442M (1999; Rev. A) Gypsum Backing Board and  
Coreboard
- ASTM C 475 (1994) Joint Compound and Joint Tape for  
Finishing Gypsum Board
- ASTM C 514 (1996) Nails for the Application of Gypsum  
Board
- ASTM C 557 (1999) Adhesives for Fastening Gypsum  
Wallboard to Wood Framing
- ASTM C 630/C 630M (2001) Water-Resistant Gypsum Backing Board
- ASTM C 840 (2001) Application and Finishing of Gypsum  
Board
- ASTM C 954 (2000) Steel Drill Screws for the  
Application of Gypsum Board or Metal  
Plaster Bases to Steel Studs from 0.033  
in. (0.84 mm) to 0.112 in. (2.84 mm) in  
Thickness
- ASTM C 960/C 960M (1997) Predecorated Gypsum Board

## ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003

ASTM C 1002	(2000) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases
ASTM C 1047	(1999) Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C 1177/C 1177M	(1999) Standard Specification for Glass Mat Gypsum Substrate for use as Sheathing
ASTM C 1178/C 1178M	(1999) Glass Mat Water-Resistant Gypsum Backing Board
ASTM C 1396/C 1396M	(2000) Standard Specification for Gypsum Board
ASTM D 226	(1997) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 412	(1998) Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
ASTM D 624	(2000) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1037	(1999) Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D 1149	(1999) Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber
ASTM D 2394	(1999) Standard Method for Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM D 5420	(1998) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)
ASTM E 84	(2001) Surface Burning Characteristics of Building Materials
ASTM E 695	(1997) Standard Method for Measure Relative Resistance of Wall, Floor and Roof Construction to Impact Loads

## GYPSUM ASSOCIATION (GA)

GA 214	(1996) Recommended Levels of Gypsum Board Finish
GA 216	(2000) Application and Finishing of Gypsum Board
GA 224	(1997) Installation of Predecorated Gypsum Board
GA 253	(1999) Application of Gypsum Sheathing
GA 600	(2000) Fire Resistance and Sound Control Design Manual

## UNDERWRITERS LABORATORIES (UL)

UL Fire Resist Dir	(2000) Fire Resistance Directory
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## 1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

## SD-03 Product Data

Gypsum Wallboard

Water-Resistant Gypsum Board

Steel Framing

Fire Rated Gypsum Board

Finishing Materials and Accessories

Manufacturer's product data indicating compliance with specifications.

## 1.3 DELIVERY, STORAGE, AND HANDLING

## 1.3.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

## 1.3.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

Provide adequate ventilation to prevent condensation.

### 1.3.3 Handling

Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

## 1.4 ENVIRONMENTAL CONDITIONS

### 1.4.1 Temperature

Maintain a uniform temperature of not less than 10 degrees C in the structure for at least 48 hours prior to, during, and following the application of gypsum board, cementitious backer units, and joint treatment materials, or the bonding of adhesives.

### 1.4.2 Exposure to Weather

Protect gypsum board and cementitious backer unit products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

## 1.5 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of 5 years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of 3 years of documented successful experience.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Conform to specifications, standards and requirements specified herein. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

#### [AM0005]

##### 2.1.1 Steel Framing Components for Suspended and Furred Ceilings

Provide components complying with ASTM C 754 for conditions indicated.

a. Cast-in-Place and Postinstalled Anchors in Concrete: Capable of sustaining a load equal to 5 times that imposed by ceiling construction as determined by testing according to ASTM E 488.

b. Powder-Actuated Fasteners in Concrete: Corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190.

c. Wire Ties: ASTM A 641M, Class 1 zinc coating, soft temper, 1.6mm

(0.062 inch) thick.

d. Wire Hangers: ASTM A 641M, Class 1 zinc coating, soft temper, 4.1mm (0.162 inch) diameter

e. Steel Studs for Furring Channels: ASTM C 645, in depth indicated and with 0.45mm (0.0179 inch) minimum base metal thickness, unless otherwise indicated.

Protective Coating: ASTM A 653, G40 (ASTM A 653M, Z90) hot-dip galvanized coating for framing for exterior soffits and ceiling suspension members in areas within 3 m (10 ft) of exterior walls.

f. Steel Rigid Furring Channels: ASTM C 645, hat shaped, 0.45mm (0.0179 inch) minimum base metal thickness, unless otherwise indicated.

Protective Coating: ASTM A 653, G40 (ASTM A 653M, Z90) hot-dip galvanized coating for framing for exterior soffits and ceiling suspension members in areas within 3 m (10 ft) of exterior walls.

g. Grid Suspension System for Interior ceilings: ASTM C 645, manufacturer's standard direct-hung system.

#### 2.1.2 Steel Framing for Interior Walls and Partitions

Provide steel framing members complying with the following requirements:

a. Protective Coating: ASTM A 653, G 40 (ASTM A 653M, Z90) hot-dip galvanized coating for framing members attached to and within 3 m (10 feet) of exterior wall.

b. Steel Studs and Runners: ASTM C 645, in depth indicated and with 0.96 mm (0.0299 inch) minimum base metal thickness, unless otherwise indicated.

c. Steel Rigid Furring Channels: ASTM C 645, hat shaped, in depth indicated and with 0.45mm (0.0179 inch) minimum base metal thickness, unless otherwise indicated.

d. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.84mm (0.0329 inch), designed for screw attachment to steel studs and steel rigid furring channels used for furring.

#### 2.1.3 Steel Framing Components for Exterior Walls

See Section 05400.

#### 2.1.4 Gypsum Board

ASTM C 36/C 36M and ASTM C 1396/C 1396M.

##### 2.1.4.1 Regular

1200 mm wide, 15.9 mm thick, tapered edges.

2.1.4.2 Type X (Special Fire-Resistant)

1200 mm wide, 15.9 mm thick, tapered edges.

2.1.5 Gypsum Backing Board

ASTM C 442/C 442M, gypsum backing board shall be used as a base in a multilayer system.

2.1.5.1 Regular

1200 mm wide, 15.9 mm thick, square edges.

2.1.5.2 Type X (Special Fire-Resistant)

1200 mm wide, 15.9 mm thick, square edges.

2.1.6 Regular Water-Resistant Gypsum Backing Board

ASTM C 630/C 630M

2.1.6.1 Regular

1200 mm wide, 15.9 mm thick, tapered edges.

2.1.6.2 Type X (Special Fire-Resistant)

1200 mm wide, 15.9 mm thick, tapered edges.

2.1.7 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C 1178/C 1178M

2.1.7.1 Regular

1200 mm wide, 15.9 mm thick, square edges.

2.1.7.2 Type X (Special Fire-Resistant)

1200 mm wide, 15.9 mm thick, square edges.

2.1.8 Glass Mat Covered or Reinforced Gypsum Sheathing

Exceeds physical properties of ASTM C 79/C 79M and ASTM C 1177/C 1177M. Provide 15.9, mm, gypsum sheathing. Gypsum board shall consist of a noncombustible water-resistant core, with a glass mat surfaces embedded to the gypsum core or reinforcing embedded throughout the gypsum core. Gypsum sheathing board shall be warranted for at least 6 months against delamination due to direct weather exposure. Provide continuous, asphalt impregnated, building felt to cover exterior face of sheathing.

2.1.9 Impact Resistant Gypsum Board

1200 mm wide, 15.9 mm thick, tapered edges.

Reinforced gypsum panel with imbedded fiber mesh or lexan backing testing in accordance with the following tests. Provide fasteners that meet manufacturer requirements and specifications stated within this section. Impact resistant gypsum board, when tested in accordance with ASTM E 84, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

#### 2.1.9.1 Structural Failure Test

ASTM E 695 or ASTM D 2394 for structural failure (drop penetration). ASTM E 695 using a 27.2 kg sand filled leather bag, resisting no less than 407 N-m cumulative impact energy before failure or ASTM D 2394 using 139.7 mm hemispherical projectile resisting no less than 357 N-m before failure. Test specimen stud spacing shall be 406 mm or greater on center.

#### 2.1.9.2 Indentation Test

ASTM D 5420 or ASTM D 1037 for indentation resistance. ASTM D 5420 using a .907 kg weight with a 16 mm hemispherical impacting head dropped once 915 mm creating not more than 3.5 mm indentation or ASTM D 1037 using no less than 213 kg weight applied to the 11.13 mm diameter ball to create not more than a 0.5 mm indentation depth.

#### 2.1.10 Cementitious Backer Units

ANSI A118.9.

#### 2.1.11 Joint Treatment Materials

ASTM C 475.

##### 2.1.11.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

##### 2.1.11.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

##### 2.1.11.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

##### 2.1.11.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

##### 2.1.11.5 Joint Tape

Cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape

recommended by the manufacturer.

#### 2.1.12 Fasteners

##### 2.1.12.1 Screws

ASTM C 1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.84 mm thick. ASTM C 954 steel drill screws for fastening gypsum board to steel framing members 0.84 to 2.84 mm thick. Provide cementitious backer unit screws with a polymer coating.

#### 2.1.13 Adhesives

Do not use adhesive containing benzene, carbon tetrachloride, or trichloroethylene.

#### 2.1.14 Shaftwall Liner Panel

ASTM C 442/C 442M. Shaftwall liner panel shall conform to UL Fire Resist Dir for the Design Number(s) indicated. Liner Panel shall be specifically manufactured for cavity shaftwall system, with water-resistant paper faces, bevel edges, single lengths to fit required conditions, 25.4 mm thick, by 610 mm wide.

#### 2.1.15 Accessories

ASTM C 1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

#### 2.1.16 Asphalt Impregnated Building Felt

The moisture barrier over gypsum sheathing shall be 6.7 kg asphalt impregnated felt conforming to ASTM D 226 Type I (No. 15).

#### 2.1.17 Water

Clean, fresh, and potable.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

##### 3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and

cementitious backer units.

### 3.1.2 Concrete Walls

Verify that surfaces of concrete walls to receive gypsum board applied with adhesive are dry, free of dust, oil, form release agents, protrusions and voids, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

## 3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C 840 or GA 216 and the requirements specified herein. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length. Cut out gypsum board as required to make neat close joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Surfaces of gypsum board and substrate members may be bonded together with an adhesive, except where prohibited by fire rating(s). Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

### 3.2.1 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C 840, System VIII or GA 216.

### 3.2.2 Arches and Bending Radii

Apply gypsum board in accordance with ASTM C 840, System IX or GA 216.

### 3.2.3 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

In dry areas (areas other than tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply glass matt water-resistant gypsum tile backing board in accordance with ASTM C 840, System X or GA 216.

### 3.2.4 Exterior Application

Apply exterior gypsum board (such as at soffits) in accordance with ASTM C 840, System XI or GA 216.

### 3.2.5 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply gypsum sheathing in accordance to gypsum association publication GA 253. Design details for joints and fasteners shall follow gypsum sheathing manufacturer's requirements and be properly installed to protect the substrate from moisture intrusion. Exposed surfaces of the gypsum sheathing shall not be left exposed beyond the manufacture's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 150 mm. Openings shall be properly flashed.

### 3.2.6 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C 840, System XIII or GA 216, unless indicated otherwise. Control joints between studs in fire-rated construction shall be filled with firesafing insulation to match the fire-rating of construction.

### 3.2.7 Application of Impact Resistant Gypsum Board

Apply in accordance with applicable system of ASTM C 840 as specified or GA 216. Follow manufacturers written instructions on how to cut, drill and attach board.

## 3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

### 3.3.1 Application

In wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply cementitious backer units in accordance with ANSI A108.11. A 7.6 kg asphalt impregnated, continuous felt paper membrane shall be placed behind cementitious backer units, between backer units and studs or base layer of gypsum board. Membrane shall be placed with a minimum 150 mm overlap of sheets laid shingle style.

### 3.3.2 Joint Treatment

ANSI A108.11.

## 3.4 FINISHING OF GYPSUM BOARD

Prime and finish gypsum board in accordance with ASTM C 840, GA 214 and GA 216. Plenum areas above ceilings shall be finished to Level 1 in accordance with GA 214. Water resistant gypsum backing board, ASTM C 630/C 630M, to receive ceramic tile shall be finished to Level 2 in accordance with GA 214. Walls and ceilings to receive a heavy-grade wall covering or heavy textured finish before painting shall be finished to Level 3 in accordance with GA 214. Walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings shall be finished to Level 4 in accordance with GA 214. Unless otherwise specified, all gypsum board walls, partitions and ceilings shall be finished to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer.

### 3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum

board surface, after the two-coat joint and fastener treatment is complete and dry.

### 3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07900a "Joint Sealing." Apply material with exposed surface flush with gypsum board or cementitious backer units.

### 3.6 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resist Dir for the Design Number(s) indicated, or GA 600 for the File Number(s) indicated. Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL test requirements or GA requirements. Penetrations through rated partitions and ceilings shall be sealed tight in accordance with tested systems. Fire ratings shall be as indicated.

### 3.7 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finish as specified.

### 3.8 SHAFT WALL FRAMING

The shaft wall system shall be installed in accordance with the system manufacturer's published instructions. Bucks, anchors, blocking and other items placed in or behind shaft wall framing shall be coordinated with electrical and mechanical work. Fireproofing materials which are damaged or removed during shaft wall construction shall be patched or replaced.

-- End of Section --

## SECTION 09915

## COLOR SCHEDULE

## PART 1 GENERAL

## 1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

## 1.2 SUBMITTALS

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

## SD-04 Samples

## Color Schedule; G

Six sets of color boards, 120 days after the Contractor is given Notice to proceed, complying with the following requirements:

- a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
- b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.
- c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.

## PART 2 PRODUCTS

## 2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal

colors from other manufacturers.

PART 3 EXECUTION (Not Applicable)

-- End of Section --

2.2 Color Schedule

Material	Mark	Location (See finish schedule on drawings for specific interior locations)	Manufacturer/Color/Pattern Product Name and Number
<b>EXTERIOR</b>			
Glass		All exterior entrances and windows	Solarbronze
EIFS		Exterior wall panels	Parex "Bamboo" #10425(66)
Concrete		All exposed precast and cast-in-place concrete	Sonneborn StuccoCryl "Amarilla" #3003
Factory Finished Metal Systems		All exterior roofing, soffits, fascia, trim, rain drainage devices, roof system flashings	Manufacturer's standard dark brown to match existing metal roofing on site.
Site-Painted Metals		Hollow metal doors and frames, miscellaneous flashings and trim	Match adjacent surfaces
Aluminum		All exterior aluminum entrances and windows	Dark Bronze Anodized
<b>INTERIOR</b>			
Porcelain Paver Tile	PP1	Floor: Lobby, Lobby corridors, Vestibules, Telephone Rooms, Vending Areas	DAL Tile "Rosso" #CD23
Porcelain Paver Tile	PP2	Public toilet room floors. Note: Base to be the same tile, 102mm high.	Floor Gres "Terra 2 TU"
Porcelain Wall Tile	PP3	Public toilet room walls.	DAL Tile "Gold Dust" #5202
Porcelain Wall Tile	PP4	Public toilet room walls - accent	DAL Tile "Viminale (Natural)" #AM03
Ceramic Mosaic Tile	CT5	Dorm room toilet area floor. Base to be the same tile with sanitary cove to 102mm high.	DAL Tile "Dapple Gray" (Spectrastone) #D326
Ceramic Wall Tile	CT6	Dorm room toilet area walls.	DAL Tile "Pumice" (Spectrastone) #D336
Ceramic Wall Tile	CT7	Dorm room toilet area walls - accent	DAL Tile "Burgundy" #DC13
Ceramic Wall Tile	CT8	Dorm room toilet area walls - accent	DAL Tile "Midnight Blue" #DC10
Quarry Tile	QT9	Laundry Floor. Note: Base to be the same tile 153mm high, with sanitary cove, bullnose top and formed corners	DAL Tile "Arid Flash" #OQ48
Linoleum	L1	Corridors, Dayrooms, Swelling Room Entryway, Dwelling Room Vanity Area floor	Azrock Linosom Linoleum "Veneto" #6637
Carpet #1	CPT1	Sleeping Rooms, All Office Areas, Reception/Briefing Room, Computer Room	Design Weave "Pacifica", "San Mateo", #Z0945-00779
Resilient Base	RB1	Use in lobby, corridors, dayroom, vestibules, telephone rooms, vending areas	Roppe "Toffee" #F182
Resilient Base	RB2	Use with Design Weave "Pacifica" and room entryways and room vanity areas	Roppe "Deep Navy" #9139
Resilient Base	RB3	All utility areas - anywhere with sealed concrete floors.	Roppe "Black-Brown" #P193
Solid Surface	SP1	Public toilet room countertops.	Fountainhead "Federal Cornerstone" #FR-6-6
Solid Surface	SP2	Dorm room vanity area; with integral sing.	Fountainhead "State Blue Classix" #FC-3-2
Solid Surface	SP3	Lobby desk counter tops and front trim.	Fountainhead "Sand Beige" #FS-2-2
Semi-Rigid Vinyl Wall Protection Fabric	SWP1	Corridors, Vestibules, Reception/Briefing	Acrovyn semi-rigid wall protection: 0.030 thickness, Texture #27 (Quartz), Color: "Harvest" #759
Paint	PT1	All finished drywall ceilings	Benjamin Moore #915
Paint	PT2	All walls except those specified for vinyl wallcovering	Benjamin Moore #1067
Paint	PT3	Hollow metal door frames and other miscellaneous trim.	Benjamin Moore #1085
Texture Coating	PT4	All exposed concrete ceilings	Benjamin Moore #915
Plastic Laminate	PL1	Wood Doors	Pionite Fine-Oak #WO951-S
Plastic Laminate	PL2	Lobby counter cabinets, Laundry counters	Pionite Caramel #ST622-S
Plastic Laminate	PL3	Room Unit Vanity Area Cabinet Doors	Pionite "Folkstone Gray" #SG241-S
Acoustical Ceiling Panels & Grid	AC1	All locations where scheduled	Manufacturer's Standard White
Rigid Wall Protection Panels	RWP1	Central stairwell and all telephone rooms - 1800mm high wainscot	C/S Acrovyn Rigid Panels: 0.060 thickness, Pellette Texture, Color: "Parchment" #253.
Sealed Concrete		Where scheduled	No color

-- End of Section --

## SECTION 15400A

## 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 1010 (1994) Self-Contained, Mechanically Refrigerated Drinking-Water Coolers
- ARI 700 (1999) Specifications for Fluorocarbon and Other Refrigerants

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI Z21.10.1 (1998; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas Water Heaters Vol. I, Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
- ANSI Z21.10.3 (1998) Gas Water Heaters Vol.III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters
- ANSI Z21.22 (1999) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems
- ANSI Z21.56 (1994; Z21.56a) Gas-Fired Pool Heaters
- ANSI Z358.1 (1998) Emergency Eyewash and Shower Equipment

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 105/A 105M (2001) Carbon Steel Forgings for Piping Applications
- ASTM A 183 (1998) Carbon Steel Track Bolts and Nuts
- ASTM A 193/A 193M (2001a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 515/A 515M	(1989; R 1997) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 518/A 518M	(1999) Corrosion-Resistant High-Silicon Iron Castings
ASTM A 53/A 53M	(2001) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 1999el) Ductile Iron Castings
ASTM A 733	(1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 74	(1998) Cast Iron Soil Pipe and Fittings
ASTM A 888	(1998el) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 111	(1998) Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B 111M	(1998) Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock (Metric)
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 152	(1997a) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 152M	(1997a) Copper Sheet, Strip, Plate, and Rolled Bar (Metric)
ASTM B 306	(1999) Copper Drainage Tube (DWV)
ASTM B 32	(1996) Solder Metal
ASTM B 370	(1998) Copper Sheet and Strip for Building Construction
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1998) Seamless Red Brass Pipe, Standard Sizes

ASTM B 584	(2000a) Copper Alloy Sand Castings for General Applications
ASTM B 75	(1999) Seamless Copper Tube
ASTM B 75M	(1999) Seamless Copper Tube (Metric)
ASTM B 813	(2000) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(2000) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM C 1053	(2000) Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM C 564	(1997) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM D 1004	(1994; Rev. A) Initial Tear Resistance of Plastic Film and Sheetting
ASTM D 1248	(2000) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1785	(1999) Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1999) Rubber Products in Automotive Applications
ASTM D 2235	(1996a) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(1999) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2447	(1999) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter

ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1999) Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2485	(1991; R 1996) Evaluating Coatings for High Temperature Service
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2661	(1997ael) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(2000) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2683	(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(1999) Polyethylene (PE) Plastic Tubing
ASTM D 2822	(1991; R 1997el) Asphalt Roof Cement
ASTM D 2846/D 2846M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
ASTM D 2855	(1996) 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 3035	(1995) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3122	(1995) Solvent Cements for Styrene-Rubber

	(SR) Plastic Pipe and Fittings
ASTM D 3138	(1995) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4060	(1995) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4101	(2000) Propylene Plastic Injection and Extrusion Materials
ASTM D 4551	(1996) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM D 638	(1999) Tensile Properties of Plastics
ASTM D 638M	(1998) Tensile Properties of Plastics (Metric)(Withdrawn 1998; no replacement)
ASTM E 1	(1998) ASTM Thermometers
ASTM E 96	(2000) Water Vapor Transmission of Materials
ASTM F 1290	(1998a) Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F 1760	(1997) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F 409	(1999a) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings

## ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003

ASTM F 437	(1999) Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 438	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F 439	(1999) Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(1999) Chlorinated Poly(Vinyl Chloride).(CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442/F 442M	(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F 477	(1999) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493	(1997) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 628	(2000) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core
ASTM F 877	(2001) Crosslinked Polyethylene (PEX) Plastic Hot- and Cold- Water Distribution Systems
ASTM F 891	(2000) Coextruded Poly (Vinyl chloride) (PVC) Plastic Pipe with a Cellular Core
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)	
ASHRAE 34	(1997) Number Designation and Safety Classification of Refrigerants
ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i; 90.1l-1995; 90.1m-1995; 90.1n-1997) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)	
ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1002	(1986) Water Closet Flush Tank Ball Cocks

ASSE 1003	(1995) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1986) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1006	(1989) Residential Use (Household) Dishwashers
ASSE 1011	(1995) Hose Connection Vacuum Breakers
ASSE 1012	(1995) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1999) Reduced Pressure Principle Backflow Preventers
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1020	(1998) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage)
ASSE 1037	(1990; Rev thru Mar 1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures
AMERICAN WATER WORKS ASSOCIATION(AWWA)	
AWWA B300	(1999) Hypochlorites
AWWA B301	(1992; Addenda B301a - 1999) Liquid Chlorine
AWWA C105	(1999) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C203	(1997; Addenda C203a - 1999) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C700	(1995) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA D100	(1996) Welded Steel Tanks for Water Storage
AWWA EWW	(1999) Standard Methods for the

## Examination of Water and Wastewater

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

## ASME INTERNATIONAL (ASME)

ASME A112.1.2

(1991; R 1998) Air Gaps in Plumbing Systems

ASME A112.14.1

(1975; R 1998) Backwater Valves

ASME A112.18.1M

(1996) Plumbing Fixture Fittings

ASME A112.19.1M

(1994; R 1999) Enameled Cast Iron Plumbing  
Fixtures

ASME A112.19.2M

(1998) Vitreous China Plumbing Fixtures

ASME A112.19.3M

(1987; R 1996) Stainless Steel Plumbing  
Fixtures (Designed for Residential Use)

ASME A112.19.4M

(1994; Errata Nov 1996) Porcelain Enameled  
Formed Steel Plumbing Fixtures

ASME A112.21.1M

(1991; R 1998) Floor Drains

ASME A112.21.2M

(1983) Roof Drains

ASME A112.36.2M

(1991; R 1998) Cleanouts

ASME A112.6.1M

(1997) Supports for Off-the-Floor Plumbing  
Fixtures for Public Use

ASME B1.20.1

(1983; R 1992) Pipe Threads, General  
Purpose (Inch)

ASME B16.12

(1998) Cast Iron Threaded Drainage Fittings

ASME B16.15

(1985; R 1994) Cast Bronze Threaded  
Fittings Classes 125 and 250

ASME B16.18

(1984; R 1994) Cast Copper Alloy Solder  
Joint Pressure Fittings

ASME B16.21

(1992) Nonmetallic Flat Gaskets for Pipe  
Flanges

ASME B16.22	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.24	(1991; R 1998) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.34	(1997) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B16.4	(1998) Gray Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B31.1	(1998) Power Piping
ASME B31.5	(1992; B31.5a1994) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPVC SEC VIII D1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPVC SEC IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1998) Controls and Safety Devices for Automatically Fired Boilers

## CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings

for Sanitary and Storm Drain, Waste, and  
Vent Piping Applications

CISPI HSN-85 (1985) Neoprene Rubber Gaskets for Hub and  
Spigot Cast Iron Soil Pipe and Fittings

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA Tube Handbook (1995) Copper Tube Handbook

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH  
(FCCCHR)

FCCCHR-CCC (1993) Manual of Cross-Connection Control

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5 (1994) Centrifugal Pumps

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS  
(IAPMO)

IAPMO Z124.1 (1995) Plastic Bathtub Units

IAPMO Z124.3 (1995) Plastic Lavatories

IAPMO Z124.5 (1997) Plastic Toilet (Water Closets) Seats

IAPMO Z124.9 (1994) Plastic Urinal Fixtures

INTERNATIONAL CODE COUNCIL (ICC)

CABO A117.1 (1998) Accessible and Usable Buildings and  
Facilities

ICC Plumbing Code (2000) International Plumbing Code (IPA)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-110 (1996) Ball Valves Threaded,  
Socket-Welding, Solder Joint, Grooved and  
Flared Ends

MSS SP-25 (1998) 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

ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003

MSS SP-69 (1996) Pipe Hangers and Supports -  
Selection and Application

MSS SP-70 (1998) Cast Iron Gate Valves, Flanged and  
Threaded Ends

MSS SP-71 (1997) Gray Iron Swing Check Valves,  
Flanges and Threaded Ends

MSS SP-72 (1999) Ball Valves with Flanged or  
Butt-Welding Ends for General Service

MSS SP-73 (1991; R 1996) Brazing Joints for Copper  
and Copper Alloy Pressure Fittings

MSS SP-78 (1998) Cast Iron Plug Valves, Flanged and  
Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check  
Valves

MSS SP-83 (1995) Class 3000 Steel Pipe Unions  
Socket-Welding and Threaded

MSS SP-85 (1994) Cast Iron Globe & Angle Valves,  
Flanged and Threaded Ends

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31 (2001) Installation of Oil Burning  
Equipment

NFPA 54 (1999) National Fuel Gas Code

NFPA 90A (1999) Installation of Air Conditioning  
and Ventilating Systems

## NSF INTERNATIONAL (NSF)

NSF 14 (1999) Plastics Piping Components and  
Related Materials

NSF 3 (1996) Commercial Spray-Type Dishwashing  
and Glasswashing Machines

NSF 5 (1992) Water Heaters, Hot Water Supply  
Boilers, and Heat Recovery Equipment

NSF 61 (1999) Drinking Water System Components -

## Health Effects (Sections 1-9)

## PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01 (1998) Plastic Pipe in Fire Resistive Construction

## PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G 101 (1996) Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data

PDI WH 201 (1992) Water Hammer Arresters

## PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (NAPHCC)

NAPHCC Plumbing Code (1996) National Standard Plumbing Code

## SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J 1508 (1997) Hose Clamps

## THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5 (1994) White Metal Blast Cleaning

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-240 (Rev A; Canc. Notice 1) Shower Head, Ball Joint

CID A-A-50012 (Basic) Garbage Disposal Machine, Commercial

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

10 CFR 430 Energy Conservation Program for Consumer Products

21 CFR 175 Indirect Food Additives: Adhesives and Components of Coatings

PL 93-523 (1974; Amended 1986) Safe Drinking Water Act

## UNDERWRITERS LABORATORIES (UL)

UL 174 (1996; Rev thru Oct 1999) Household Electric Storage Tank Water Heaters

UL 430 (1994; Rev thru Nov 1996) Waste Disposers

UL 732 (1995; Rev thru Jan 1999) Oil-Fired

## Storage Tank Water Heaters

UL 749

(1997; Rev thru Feb 1999) Household  
Dishwashers

UL 921

(1996) Commercial Electric Dishwashers

## 1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

## 1.3 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

## 1.4 SUBMITTALS

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

## SD-02 Shop Drawings

## Plumbing System.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

## Electrical Schematics.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

#### SD-03 Product Data

##### Welding.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

##### Plumbing Fixture Schedule; G.

Catalog cuts of specified plumbing fixtures valves and related piping system and system location where installed.

##### Vibration-Absorbing Features; G.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

##### Plumbing System; .

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

#### SD-06 Test Reports

##### Tests, Flushing and Disinfection.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

##### Backflow Prevention Assembly Tests..

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

#### SD-07 Certificates

##### Materials and Equipment

Where materials or equipment are specified to comply with

requirements of AGA, ASME, or NSF proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts.

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

#### SD-10 Operation and Maintenance Data

Plumbing System.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

### 1.5 PERFORMANCE REQUIREMENTS

#### 1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC 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 05090A WELDING, STRUCTURAL.

### 1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with ICC Plumbing Code.

### 1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II.

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8.

End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

#### 2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310
- b. Coupling for Steel Pipe: AWWA C606.
- c. Couplings for Grooved Pipe: Malleable Iron ASTM A 47/A 47M, Grade 32510. Copper ASTM A 536.
- d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1.6 mm (1/16 inch) thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- e. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.
- f. Brazing Material: Brazing material shall conform to AWS A5.8,

BCuP-5.

- g. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.
- h. Solder Material: Solder metal shall conform to ASTM B 32.
- i. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.
- j. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.
- k. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.
- l. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 110 degrees C (230 degrees F).
- m. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM 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 and ASTM D 2855.
- r. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493.
- s. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.
- t. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D 3122.

#### 2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrester: PDI WH 201.

ACCOMPANYING AMENDMENT NO. 0005 TO SOLICITATION NO. DACA63-03-R-0003

- b. Copper, Sheet and Strip for Building Construction: ASTM B 370.
- c. Asphalt Roof Cement: ASTM D 2822.
- d. Hose Clamps: SAE J 1508.
- e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
- f. Metallic Cleanouts: ASME A112.36.2M.
- g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.
- h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:  
AWWA C203.
- i. Hypochlorites: AWWA B300.
- j. Liquid Chlorine: AWWA B301.
- k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.
- l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.
- m. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 65 mm (2-1/2 inches) and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm (3 inches) and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67

Description	Standard
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
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 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 20 mm (3/4 inch) male inlet threads, hexagon shoulder, and 20 mm (3/4 inch) hose connection. Faucet handle shall be securely attached to stem.

### 2.3.2 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be

provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm (3/4 inch) exposed hose thread on spout and 20 mm (3/4 inch) male pipe thread on inlet.

### 2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 59 kW (200,000 Btuh) shall have 20 mm (3/4 inch) minimum inlets, and 20 mm (3/4 inch) outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh) shall have 25 mm (1 inch) minimum inlets, and 25 mm (1 inch) outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

### 2.3.4 Thermostatic Mixing Valves

Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 2 degrees C of any setting.

## 2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC Plumbing Code. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.

Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin,

fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82 degrees C (180 degrees F) water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

#### 2.4.1 Lavatories

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.

#### 2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-CCC. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

#### 2.6 DRAINS

##### 2.6.1 [AM002]Floor and Shower Drains (FD-1)

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 connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

##### [AM002]

##### ~~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 (12 inch) nominal overall width or diameter and 250 mm (10 inch) 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 (12 inch) nominal overall width or diameter and 250 mm (10 inch) 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.~~

#### 2.6.2 Floor Drains (FD-2)

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 connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

#### 2.6.3 Boiler Room Drain (FD-3)

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 ( inches). The grate area shall be not less than 0.065 meters (100 square inches).

## 2.7 SHOWER PAN

Shower pan may be copper, or nonmetallic material.

## 2.7.1 Sheet Copper

Sheet copper shall be 4.9 kg per square meter (16 ounce) weight.

## 2.7.2 Plasticized Polyvinyl Chloride Shower Pan Material

Material shall be sheet form. The material shall be 1.016 mm (0.040 inch) 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 1.016 mm (0.040 inch) minimum thickness of nonplasticized PVC and shall have the following minimum properties:

## a. ASTM D 638M or :

Ultimate Tensile Strength:	1.79 MPa (2600 psi)
Ultimate Elongation:	398 percent
100 Percent Modulus:	3.07 MPa (445 psi)

## b. ASTM D 1004:

Tear Strength:	53 kilonewtons per meter (300 pounds per inch)
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## c. ASTM E 96:

Permeance:	0.46 ng per Pa per second per square meter (0.008 perms)
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## d. Other Properties:

Specific Gravity:	1.29
PVC Solvent:	Weldable
Cold Crack:	minus 47 degrees C (-53 degrees F)
Dimensional stability, 100 degrees C (212 minus 2.5 percent degrees F)	
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 0.813 mm (0.032 inch) thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer

and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 50 mm (2 inches). The interior diameter shall be not more than 3.2 mm (1/8 inch) over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

## 2.9 [AM002] OIL SEPARATOR

The oil separator shall have a fabricated steel body with an acid resistant interior coating. The cover shall be of non-skid construction and secured with a gasket for an airtight seal. The unit shall have a bronze cleanout plug and visible double wall trap seal. The unit shall contain a removable combination pressure equalizing flow diffusing baffle and sediment bucket, a horizontal baffle, oil draw-off port, and vent connections. Furnish unit complete with a flow control fitting, backwater valve, and integral storage tank. The unit shall have capacities as listed on the drawings.

## 2.10 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 32 to 71 degrees C (90 to 160 degrees F). Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 49 to 82 degrees C (120 to 180 degrees F). Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 2000 liters storage capacity need not meet the standard loss requirement if the tank surface area is insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 93 degrees C water temperature and 1034 kPa working pressure. The expansion tank size and acceptance volume shall be as indicated.

### 2.10.1 Automatic Storage Type

Heaters shall be complete with control system, and shall have ASME rated combination pressure and temperature relief valve. A phenolic resin coating shall be provided.

### 2.10.2 Phenolic Resin Coatings

The phenolic resin coating shall be applied at either the coil or coating manufacturer's factory. The coil shall be chemically cleaned to remove any scale if present and to etch the metal surface. The exposed exterior surface of the coil shall be abrasively cleaned to white metal blast in accordance with SSPC SP 5. The coating shall be a product specifically intended for use on the material the water heating coils are made of and shall be acceptable for use in potable water systems. Steel, copper, copper alloy, or stainless steel coatings shall be capable of withstanding temperatures up to 204 degrees C (400 degrees F) dry bulb; and meet the requirements of 21 CFR 175. The entire exterior surface of each coil shall be coated with three component phenolic resin coating system. The system shall consist of the following: wash primer, pigmented base coat, and the clear top coat. Immediate and final cure times and temperatures shall be as recommended by the coating manufacturer.

#### 2.10.2.1 Wash Primer

The wash primer shall be composed of a combination of polyvinyl butyral and a heat hardening phenolic resin. The weight per liter (gallon) shall be between 0.8388 kg per liter (7.0 lbs. per gallon) minimum and 0.8867 kg per liter (7.4 lbs. per gallon) maximum.

#### 2.10.2.2 Pigmented Base Coat

The pigmented baking phenolic base coat shall consist of heat hardening phenolic resins, suitable pigments of the earth type, and softening agents, and shall not contain drying oils or cellulose material. The weight per liter (gallon) shall be between 1.2 kg per liter (10.3 lbs per gallon) minimum and 1.3 kg per liter (10.7 lbs per gallon) maximum. The non-volatile solids content shall be between 60 percent minimum and 64 percent maximum by weight.

#### 2.10.2.3 Clear Top Coat

The clear non-pigmented baking phenolic top coat shall have a weight per liter (gallon) of between 1.0 kg per liter (8.65 lbs per gallon) minimum and 1.1 kg per liter (8.95 lbs per gallon) maximum. The non-volatile solids content shall be between 48 percent minimum and 52 percent maximum by weight.

#### 2.10.2.4 Certificate of Compliance

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.

#### 2.10.2.5 Test Panels

Steel test panel substrate shall be 0.607 mm (24 gauge) in thickness. The panels shall be coated with one coat wash primer, then pigmented baking phenolic to a dry film thickness of 0.10 to 0.15 mm, then clear baking

phenolic to a total dry film thickness of 0.13 to 0.18 mm. The panels shall then be subjected to the tests specified below:

- a. Heat Test: Test panel shall be minimum 70 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 (400 degrees F).
- 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.

## 2.11 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III as determined by the requirements of ASHRAE 90.1. Each tank shall be equipped with a thermometer, conforming to ASTM E 1, Type I, Class 3, Range C, style and form as required for the installation, and with 175 mm (7 inch) scale.

Thermometer shall have a separable socket suitable for a 20 mm (3/4 inch) tapped opening. Tanks shall be equipped with a pressure gauge 155 mm (6 inch) minimum diameter face. [AM0005] Each storage tank shall have replaceable anodes. Insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

## 2.12 PUMPS

### 2.12.1 {AM002} Sump Pumps

Sump pumps shall be close coupled FM listed submersible type. The pump body shall be cast iron construction with a corrosion resistant powder coated epoxy finish. The motor shall be oil filled, Class B, insulated, NEMA B design, FM listed for Class I, Division I and Group C and D environments, and include an integral thermal overload switch, heavy duty, permanently lubricated ball bearings with a stainless steel shaft. The seals shall be suitable for use with 32AW (25-ft) power cord. The power cord shall be SO type capable of continued exposure to the pumped liquid, sized in accordance with the National Electric Code. Each conductor in the cord shall be individually sealed to eliminate wicking of the liquids.

### 2.12.2 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 close-coupled with an

overhung impeller, or 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 wattage (horsepower) for the service required. Pump shall conform to HI 1.1-1.5. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover. Pump motors smaller than 746 W (Fractional horsepower pump motors) shall have integral thermal overload protection in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

### 2.12.3 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1.5 m 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 or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

#### 3.1.1 Water Pipe, Fittings, and Connections

##### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures,

faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

#### 3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

#### 3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

#### 3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 12 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 accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

#### 3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 20 mm (3/4 inch) hose bibb with renewable seat and full port ball valve ahead of hose bibb. At other low points, 20 mm (3/4 inch) brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

#### 3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion

loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15 m in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

#### 3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

#### 3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

#### 3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

##### 3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or

shall have a polytetrafluoroethylene tape applied.

#### 3.1.2.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

#### 3.1.2.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm (2-1/2 inches) and smaller; flanges shall be used on pipe sizes 80 mm (3 inches) and larger.

#### 3.1.2.4 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.2.5 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.

#### 3.1.2.6 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections.

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA Tube Handbook with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

- b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 50 mm (2 inches) and smaller. Soldered joints shall conform to ASME B31.5 and CDA Tube Handbook. Soldered joints shall not be used in compressed air piping between the air compressor and the receiver.
- c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC Plumbing Code using B-cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

#### 3.1.2.7 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.

#### 3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

#### 3.1.4 Corrosion Protection for Buried Pipe and Fittings

##### 3.1.4.1 Cast Iron and Ductile Iron

Pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Pipe, fittings, and joints shall have a protective coating. The protective coating shall be completely encasing polyethylene tube or sheet in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer, and wrapped with tape. The pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

##### 3.1.4.2 Steel

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

### 3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

#### 3.1.5.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for supply, drainage, waste and vent pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm (1/4 inch) clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900A JOINT SEALING. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 12 mm (1/2 inch) from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and masonry wall as

specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07840A FIRESTOPPING.

#### 3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 4.9 kg per square meter (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 250 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 200 mm 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 250 mm (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 (6 inches) in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

#### 3.1.5.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 6 to 13 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 07900A JOINT SEALING.

#### 3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840A FIRESTOPPING.

#### 3.1.7 Supports

##### 3.1.7.1 General

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

##### 3.1.7.2 Pipe 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 (4 inches) and larger when the temperature of the medium is 15 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 (4 inches).
  - (2) Be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or less.
  - (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 128 kg per cubic meter (8 pcf) or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m 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 4.5 m nor more than 2 m from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
  - (1) On pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
  - (2) On pipe less than 100 mm (4 inches) a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
  - (3) On pipe 100 mm (4 inches) and larger carrying medium less

that 15 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

- l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.
- n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

### 3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm (4 inches) will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm (4 inches). Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 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. Where cleanouts are provided with adjustable heads, the heads shall be cast iron or plastic.

### 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 150 mm above the top of the tank or water heater.

#### 3.2.2 Installation of Gas-Fired Water Heater

Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 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. A phenolic resin coating shall be provided.

#### 3.2.3 Phenolic Resin Application Process

The phenolic resin coating shall be applied at either the coil or coating manufacturer's factory. The hot water coil shall be chemically cleaned to remove any scale if present and to etch the metal surface. The exposed exterior surface of the coil shall be abrasively cleaned to white metal blast in accordance with SSPC SP 5. The exterior surface shall be coated with the three-component coating system in the following sequence and manner. For immediate and final cure times and temperature, the recommendations of the coating manufacturer shall be followed.

- a. Wash Primer. One coat of wash primer shall be applied by flooding.
- b. Pigmented Base Coat. Pigmented baking phenolic coating shall be

applied in several coats by immersion or flooding to a dry film thickness of 0.10 to 0.15 mm.

- c. Clear Top Coat. Clear non-pigmented baking phenolic top coat shall be applied in several coats by immersion or flooding. The final coat may be applied by spraying. The dry film thickness of the total coating system shall be between 0.13 and 0.18 mm.

#### 3.2.4 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.

#### 3.2.5 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

#### 3.2.6 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

### 3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

#### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

#### 3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 1 m above the floor, except at water closets intended for use by the physically handicapped where flushometer valves shall be mounted at approximately 760 mm above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle shall be installed on the wide side of the enclosure. Bumpers for water closet seats shall be installed on the flushometer spud.

### 3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 775 mm above finished floor. Wall-hung drinking fountains and water coolers shall be installed with rim 1020 mm above floor. Wall-hung service sinks shall be mounted with rim 700 mm above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

### 3.3.4 Shower 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 Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

#### 3.3.5.3 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 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 ICC Plumbing Code at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

#### 3.3.7 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 05500A 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 1 liter per 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 12 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 12 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 0.73 kg per square meter (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 75 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 inch 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 or 900 mm at a time shall be welded.

On wood subflooring, two layers of 0.73 kg per square meter (15 pound) 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 80% 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 (1-3/8 inch) minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

### 3.6.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900 PAINTS AND COATINGS.

### 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 PAINTS AND COATINGS.

### 3.9 TESTS, FLUSHING AND DISINFECTION

#### 3.9.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC Plumbing Code.

- a. Drainage and Vent Systems Test. The final test shall include a smoke test.
- b. Building Sewers Tests.
- c. Water Supply Systems Tests.

#### 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 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

### 3.9.3 System Flushing

#### 3.9.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second (4 fps) through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration.

#### 3.9.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When

the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 1 L per 24 hour period, ten times over a 14 day period.

#### 3.9.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.
- i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.
- j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

#### 3.9.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine

residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.9.6 Flushing of Potable Water System

As an option to the system flushing specified above, the potable water system shall be flushed and conditioned until the residual level of lead is less than that specified by the base industrial hygienist. The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

### 3.10 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 - IAPMO Z124.5, 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 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush.

[AM0002]

~~Flush Valve in Flush Tank - Flush valve seats in tanks for flushing water closets shall be at least 25 mm (1 inch) 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:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

P-3 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 - IAPMO Z124.5, Type A, white plastic, elongated, open front.

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 (1 inch) 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-4 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 3.8 liters per flush.

P-5 URINAL HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABP A117.1; other features are the same as P-4

P-6 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, countertop, oval, counter top mount.

Faucet - Faucets shall meet the requirements of NSF 61, Section 9. Faucets shall be single type. Faucets shall have replaceable seats and washers. Valves and handles shall be copper alloy. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

P-7 LAVATORY, HANDICAPPED:

All features are the same as P-6.

P-8 Shower: Shower heads, CID A-A-240 shall be adjustable spray type and shall include a non-removable, tamperproof device to limit water flow to 0.16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower head shall be adjustable 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 thermostatic mixing type. Shower head shall be vandalproof with integral back.

P-9 LAUNDRY SINK:

Double bowl, leg support 1219 x 508.0 mm (48 x 20 inches), stainless steel ASME A112.19.3M.

Faucet and Spout - Cast copper alloy, wrought copper alloy, cast iron, or stainless steel, with backflow preventer. Faucets shall have replaceable seat and the stem shall rotate onto the seat. Strainers shall have internal threads. Combination faucets shall be mounted on the tub back. Spouts shall be externally threaded for hose connection.

Handles - Cast copper alloy, wrought copper alloy, or stainless steel, lever type.

Traps - Copper alloy, or cast iron.

P-10 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M corner, floor mounted 711.2 mm (28 inches) square, 171.5 mm (6-3/4 inches) deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be four arm type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-11 WASHER CONNECTION BOX

The box shall be fabricated from 16 gauge steel, 9" high, 10-3/4" wide, with 2" drain connection and a white epoxy finish.

Valve - ball type with bottom supply and 1/2" sweat connection.

P-12 ELECTRIC DRINKING FOUNTAIN BI-LEVEL:

Drinking fountains shall meet the requirements of NSF 61, Section 9. Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish.

Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - One unit shall be surface wall-mounted 336.6 mm wide, 330.2 mm deep, and have a back height of 152.4 to 203.2 mm. The bowl shall be made of stainless steel. The unit shall have concealed fasteners and be for interior installation.

Handicapped - One unit shall be Handicapped type, surface wall-mounted. The dimensions shall be 381.0 mm (15 inches) wide, 508.0 mm (20 inches) deep, with a back height of 152.4 to 203.2 mm (6 to 8 inches). The unit shall clear the floor or ground by at least 200 mm (8 inches). A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm (27 inches) and between the front edge of the bowl and the body of the unit of at least 200 mm (8 inches). A 200 mm (8 inch) wide clear space shall exist on both sides of the unit. The spout height shall be no more than 1 m (36 inches) above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165.1 mm (6-1/2 inches) high, made of stainless 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 = 0 (trace is permitted).

SL = Standby loss in W/0.093 sq. m. based on 27 degrees C delta T, or in percent per hour based on nominal 38 degrees C delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.13 TABLES

TABLE I  
PIPE AND FITTING MATERIALS FOR  
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE					
		A	B	C	D	E	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 soil 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/A 47M	X	X		X	X	
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M 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 fittings for non-ferrous pipe ASTM B 75M C12200, ASTM B 152, ASTM B 152M, 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/A 53M, Type S, Grade B	X			X	X	
11	Seamless red brass pipe, ASTM B 43		X	X			

TABLE I  
 PIPE AND FITTING MATERIALS FOR  
 DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE					
		A	B	C	D	E	F
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X	
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X	
14	Seamless copper pipe, ASTM B 42				X		
15	Cast bronze threaded fittings, ASME B16.15				X	X	
16	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X	
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	
19	Acrylonitrile-Butadiene-Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D 2661, ASTM F 628	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) ASTM F 1760	X	X	X	X	X	X
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A 518/A 518M		X			X	X

SERVICE:

- A - Underground Building Soil, Waste and Storm Drain
- B - Aboveground Soil, Waste, Drain In Buildings
- C - Underground Vent

TABLE I  
 PIPE AND FITTING MATERIALS FOR  
 DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE					
		A	B	C	D	E	F
	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

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
1	Malleable-iron threaded fittings, a. Galvanized, ASME B16.3 for use with Item 4a	X	X	X	X
2	Grooved pipe couplings, ferrous pipe ASTM A 536 and ASTM A 47/A 47M, non-ferrous pipe, ASTM A 536 and ASTM A 47/A 47M,	X	X	X	
3	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47/A 47M, for use with Item 2	X	X	X	
4	Steel pipe: a. Seamless, galvanized, ASTM A 53/A 53M, Type S, Grade B  b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B	X	X	X	X
5	Seamless red brass pipe, ASTM B 43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		X
7	Seamless copper pipe, ASTM B 42	X	X		X
8	Seamless copper water tube, ASTM B 88, ASTM B 88M	X**	X**	X**	X***
9	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5 and 7	X	X	X	X

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
11	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 8 and 9	X	X	X	X
12	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2	X	X	X	
13	Polyethylene (PE) plastic pipe, Schedules 40 and 80, based on outside diameter ASTM D 2447	X			X
14	Polyethylene (PE) plastic pipe (SDR-PR), based on controlled outside diameter, ASTM D 3035	X			X
15	Polyethylene (PE) plastic pipe (SIDR-PR), based on controlled inside diameter, ASTM D 2239	X			X
16	Butt fusion polyethylene (PE) plastic pipe fittings, ASTM D 3261 for use with Items 14, 15, and 16	X			X
17	Socket-type polyethylene fittings for outside diameter-controlled polyethylene pipe, ASTM D 2683 for use with Item 15	X			X
18	Polyethylene (PE) plastic tubing, ASTM D 2737	X			X
19	Chlorinated polyvinyl chloride (CPVC) plastic hot and cold water distribution system, ASTM D 2846/D 2846M	X	X		X
20	Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedule 40	X	X		X

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
	and 80, ASTM F 441/F 441M				
21	Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR) ASTM F 442/F 442M	X	X		X
22	Threaded chlorinated polyvinyl chloride (chloride CPVC) plastic pipe fittings, Schedule 80, ASTM F 437, for use with Items 20, and 21	X	X		X
23	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings, Schedule 40, ASTM F 438 for use with Items 20, 21, and 22	X	X		X
24	Socket-type chlorinated polyvinyl chloride (CPVC) plastic pipe fittings Schedule 80, ASTM F 439 for use with Items 20, 21, and 22	X	X		X
25	Polyvinyl chloride (PVC) plastic pipe, Schedules 40, 80, and 120, ASTM D 1785	X			X
26	Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X			X
27	Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X			X
28	Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 26 and 27	X			X
29	Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X			X
30	Joints for IPS pvs pipe using solvent cement, ASTM D 2672	X			X

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
31	Filament-wound reinforced thermosetting resin (RTRP) pipe, ASTM D 2996	X	X		
32	Steel pipeline flanges, MSS SP-44	X	X		
33	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X		
34	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
35	Malleable-iron threaded pipe unions ASME B16.39	X	X		
36	Nipples, pipe threaded ASTM A 733	X	X	X	
37	Crosslinked Polyethylene (PEX) Plastic Pipe ASTM F 877.	X			X

A - Cold Water Aboveground

B - Hot Water 82 degree 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. Unfired Hot Water Storage

Volumes and inputs: maximum HL shall be 20.5 W/sq. meter

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/0.09 sq. m. 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 gallons

-- End of Section --

F

## SECTION 15500A

[AM0003] PASSIVE DESICCANT COOLING 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.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

- |             |  |
|-------------|--|
| ARI 210/240 | (1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment   |
| ARI 700     | (1999) Specifications for Fluorocarbon and Other Refrigerants        |
| ARI 1060    | (2001) Rating air to air energy recovery ventilation heat exchangers |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |             |  |
|-------------|--|
| ASTM A 307  | (2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength   |
| ASTM B 209  | (2000) Aluminum and Aluminum-Alloy Sheet and Plate   |
| ASTM B 209M | (2000) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)  |
| ASTM B 210  | (2000) Aluminum and Aluminum-Alloy Drawn Seamless Tubes  |
| ASTM B 210M | (2000) Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric)   |
| ASTM D 1784 | (1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM F 104  | (1995) Nonmetallic Gasket Materials  |

## AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

- |           |   |
|-----------|---|
| ASHRAE 15 | (1994) Safety Code for Mechanical Refrigeration |
|-----------|---|

ASHRAE 34 (1997) Number Designation and Safety  
Classification of Refrigerants

ASME INTERNATIONAL (ASME)

ASME B31.1 (1998) Power Piping

ASME BPVC SEC IX (1998) Boiler and Pressure Vessel Code;  
Section IX, Welding and Brazing  
Qualifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (1998) Motors and Generators

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Drawings; G

Drawings, at least 5 weeks prior to beginning construction, providing adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Equipment layouts which identify assembly and installation details to include energy recovery equipment.
- 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, by showing actual location in equipment, and schematically, by showing 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 loading and type of frames, brackets, stanchions, or other supports.

SD-03 Product Data

#### Verification of Dimensions

A letter, at least 2 weeks prior to beginning construction, indicating the date the site was visited, confirming existing conditions, and noting any discrepancies found.

#### Desiccant Cooling System; G

Manufacturer's catalog data, at least 5 weeks prior to beginning construction, highlighted to show model number, size, options, performance charts and curves, etc., in adequate detail to demonstrate compliance with contract requirements. Performance charts and curves shall provide performance data over the full range of outdoor conditions for which dehumidification will be required, with the conditions defined by the Contracting Officer. Manufacturer shall supply data on all energy recovery methods and equipment available for the system. Data shall include manufacturer's recommended installation instructions and procedures. 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.

#### Spare Parts

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply.

#### Qualifications

Six copies of qualification procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

#### Field Instructions

Posted instructions, at least 2 weeks prior to construction completion, including 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.

#### Performance Tests

Test schedules, at least 2 weeks prior to the start of the field tests and the system performance test. The schedules shall

identify the date, time, and location for the performance test.

#### Demonstrations

A schedule for training demonstrations, at least 2 weeks prior to the date of the proposed training course, identifying the date, time, and location for the training.

#### SD-06 Test Reports

##### Performance Tests; G

A report documenting the data taken versus the specified performance criteria, upon completion of installation and performance testing of the system. Six copies of the bound report (216 x 279 mm (8-1/2 x 11 inches) ) shall be provided. 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 C apart.

##### Inspections

A bound inspection report (216 x 279 mm (8-1/2 x 11 inches) ) at the completion of one year of service. The report shall identify the condition of the desiccant system and shall include a comparison of the condition of the desiccant system with the manufacturer's recommended operating conditions.

#### SD-07 Certificates

##### Desiccant Cooling System; G

Proof of compliance with ARI, ASHRAE, ASME, or UL requirements where specified for the system, components, or equipment. 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, shall be submitted stating that the items have been tested and conform to the requirements and testing methods of the specified agency. 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 shall self certify that his application data complies with project performance requirements.

#### SD-10 Operation and Maintenance Data

#### Operation and Maintenance Manuals;G

Six complete bound copies (216 x 279 mm (8-1/2 x 11 inches) ) of an operation and maintenance manual listing step-by-step procedures required for system startup, operation, maintenance, and shutdown. The manual shall include the manufacturer's name, model number, parts list, service manual, and a brief description of all equipment and their basic operating features. The manual shall include 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.

### 1.3 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures, using performance qualified welders and welding operators in accordance with ASME BPVC SEC 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 onsite, if practical. The welder or welding operator shall apply the assigned symbol near each weld personally made as a permanent record. Structural members shall be welded in accordance with Section 05090A WELDING, STRUCTURAL .

### 1.4 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.

### 1.5 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.

### 1.6 PROJECT/SITE CONDITIONS

#### 1.6.1 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 1.6.2 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 any other features or conditions that would affect the work to be performed and shall arrange such work accordingly,

furnishing required offsets, fittings, and accessories to meet such features or conditions.

## PART 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacturing of such products and shall essentially duplicate equipment which is similar in 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 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. 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 including 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. The system shall be a complete stand alone system with all necessary controls, motors, fans, rotors, motors, drive components, pumps, reactivation components and filtration to provide automatic continuous operation. Internal regeneration heat sources shall be a part of the system, except external heat sources may be used under the following conditions: connections to external heat sources shall be fully coordinated with the system manufacturer, and connecting equipment such as pumps, piping, traps, etc., shall be as shown on the drawings and schedules. The desiccant shall be of the solid type on a rotary wheel .

### 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 secured to the cabinet of dry desiccant units, indicating the equipment enclosed within the cabinet behind the nameplate. Cabinets shall have hinged panels, as specified, to facilitate maintenance of the component described on the nameplate secured to the cabinet.

### 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls (including variable speed control of process air flow for solid units, where applicable). 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 371 degrees C 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.

## 2.5 DESICCANT SYSTEMS

### 2.5.1 Solid Desiccant System

The unit shall be a complete, factory assembled and tested system, suitable for indoor installation. Each unit shall produce a capacity as rated in accordance with ARI 1060. It shall be designed for either curb mounting or structural steel support. The unit shall include the following components as defined in paragraph SYSTEM COMPONENTS:

- a. Desiccant Rotor
- b. Supply Fan
- c. [AM003]Return Regeneration Fan
- d. [AM0003] Dehumidification/Cooling coil~~Regeneration and Process Heating System~~
- e. Filters
- [AM0005] f. Reheat Coil

#### 2.5.1.1 Control Package

Each unit shall be factory wired and equipped with a central electrical control panel mounted inside the service compartment. Variable-speed drive controller, if provided, shall also be mounted inside the service compartment. Switched lighting shall be provided in the service

compartment so that the panel can be easily seen. Compartment shall be ventilated, if necessary, for cooling variable speed drive controller. A single power supply shall be required. All internal wiring shall be in accordance with the National Electrical Code. All electrical components required for automatic operation, based on signals from remotely mounted humidity and temperature sensors/controllers, shall be included. Connections to remote devices shall be made at the marked terminals. The internal control panel shall report discharge temperature and humidity. Additional reporting of all control data shall be available to a central control station, as specified in Section 15950A HEATING< VENTILATING< AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

#### 2.5.1.2 Unit Mounting

The unit shall be structural steel supported. The entire unit shall be isolated from the building structure on vibration isolators with submitted and published load ratings. Vibration isolators shall have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

### 2.6 SYSTEM COMPONENTS

#### 2.6.1 [AM0003] PassiveDesiccant Rotor

[AM0003]Dehumidifiers Rotor shall be non-cyclic adsorption type with a single desiccant rotary structure designed for continuous operation. Construction arrangement shall provide counter flow of [AM0003]processsupply and [AM0003]regenerationreturn air streams with full face pressure seals to prevent cross leakage with static pressure differentials up to 200 mm water gauge. The rotary structure shall consist of a stable, hygroscopic desiccant material, such as [AM0003]Molecular Sieve, Silica Gel, Titanium Silicate, or a Zeolite, deposited on a honey-combed substrate designed to maximize the desiccant area exposed to the air stream and minimize the thermal carryover from the [AM0003]regenerationreturn side to the [AM0003]adsorptionssupply side. The design shall ensure laminar air flow through the structure for minimum pressure loss. The rotor shall be complete with an electric motor with over-current protection and a speed reducer assembly driving the rotor through a flexible circumferential drive belt. A slack side belt tensioner shall be included for automatic take-up.

#### 2.6.2 Heat Exchanger

##### 2.6.2.1 ~~Thermal Rotor~~[AM0003]

~~The thermal rotor shall be of the rotary, non hygroscopic type, to minimize the transfer of water vapor between the process and regeneration sides of the unit. The rotor shall be constructed and sized to maximize the transfer of heat from the supply air stream to the regeneration air stream while minimizing the transfer of moisture back to the supply air stream. Supply and cooling air streams shall be counter flow and the component fitted with full face contact seals on both sides to prevent leakage.~~

#### 2.6.3 Fans (~~Solid~~[AM0003]Passive Desiccant System) For Supply and Return[AM0003]Regeneration

The unit shall be equipped with two belt driven backward inclined blowers. A drive belt rated for minimum 150% of motor horsepower shall be used on each motor. The supply fan motor shall have sheaves for air balancing. The motors shall be nominal 3500 RPM, NEMA B with open dripproof housings and a minimum service factor of 1.15.

#### 2.6.4 Heating and Cooling System (~~Solid~~[AM0003]Passive Desiccant System)

[AM0003] ~~Supply Regeneration and process~~ heating coils shall be of the finned tube type, and shall be constructed of 13 mm OD seamless copper tube mechanically bonded to aluminum fins. The coils shall include a flanged, heavy-gauge, galvanized steel housing for mounting to the unit. The coils shall be rated for 1135.6 kPa.

#### 2.6.5 Filters (~~Solid~~[AM0003]Passive Desiccant System)

Outside air inlets and return air plenums shall be equipped with 50 mm, [AM0002] ~~65%30%~~ minimum efficiency filters. Filters shall be pleated and disposable.

### 2.7 UNIT CONSTRUCTION

#### 2.7.1 ~~Solid~~[AM0003]Passive Desiccant System

Unit shall be suitable for [AM0003] ~~indoor outdoor~~ installation. [AM0003] ~~It shall be designed for either structural or curb mounting without field modification.~~ The enclosure system shall be air-tight (2% maximum leakage at 150% design static pressure from section to section) [AM0003] 2" double wall. The unit base shall be constructed of formed minimum 10 GA steel coated with red- oxide primer. Cross members shall be located to support each major component. Lifting lugs shall be fitted to appropriate structural members. Unit exterior shall be painted with a low-gloss enamel.

##### 2.7.1.1 Housing

The unit housing [AM0003] shall be constructed of 18 ga galvanized steel, internal partitions of 22 ga. galvanized steel with 50mm (2 inch) double wall with 3# insulation and internal partitions shall be constructed of minimum 18 GA galvanized steel with the exterior panels treated to allow for painting. All external walls shall be [AM0003] 50mm (2 inch) double wall with 3# insulation insulated with foil faced fiber glass insulation at least 25 mm thick and secured by permanent mechanical fasteners welded to the panels. Adjoining panels shall be sealed by permanent mechanical fasteners welded to the panels. Adjoining panels shall be sealed to one another with silicone compound, as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS.

##### 2.7.1.2 Service Panels

Removable service access panels shall be provided for all components. The openings shall be of sufficient size to allow service to all maintenance items. All service panels shall be provided with resilient gaskets and hardware to assure compression. Access doors shall be provided for

~~[AM0005] fan, filter, coil, wheel, and control sections, boiler and control sections and shall have continuous hinges. Roof panels shall be sealed to provide a weather tight enclosure.~~

## 2.8 DUCT WORK

### 2.8.1 Plenums and Ductwork

Desiccant units shall be provided with flanges on the air openings for duct connection. Inlet and outlet plenums shall be bolted to the flange with a gasket between the connection. Access doors, for servicing diffusers and eliminators, shall be provided in the inlet and outlet plenums. Inlet ductwork must be designed to allow uniform distribution of air across the entire opening. Outlet plenums and ductwork must allow adequate room for servicing the eliminators and must provide proper airflow through the equipment. Plenum and ductwork sizes shall be as shown and specified in Section 15895A AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

### 2.8.2 ~~[AM0003] Regenerator Exhaust Ductwork~~

~~The regenerator exhaust ductwork shall be made of glass fiber reinforced polyester (FRP) or monel. FRP must be rated for continuous duty at 82 degrees C. Duct joints should be of watertight construction. The exhaust plenum and duct should incorporate a drip collar to capture any condensation that occurs inside the duct. Long horizontal duct runs should be pitched slightly in the direction of air flow, and shall incorporate low point condensate drains.~~

## 2.9 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.9.1 Drain and Makeup Water Piping

Piping shall comply with the requirements of Section 15400A 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.

### 3.2 EQUIPMENT

Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports. Housings shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be furnished. 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 150 mm 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 80 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 cast-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.

### 3.2.1 Conditioner Solution Concentration

Contractor shall provide the conditioner solution concentration capable of maintaining the humidity level specified on the drawings.

### 3.2.2 Automatic Controls

Automatic controls for the specified desiccant system shall be provided with the desiccant 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 Sections 15895A AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and 15950A HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

### 3.2.3 General Piping, Valves, and Duct Installation

All piping, valve, and duct installation shall be made in accordance with the desiccant equipment manufacturers recommendation or in accordance with Sections 15895A AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM, 15181A CHILLED WATER PIPING AND ACCESSORIES, and 15400A PLUMBING, GENERAL PURPOSE.

## 3.3 PERFORMANCE TESTS

Before each desiccant system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's startup representative experienced in system startup and testing, at such times as directed. The tests shall measure quantities listed below. Tests shall cover a period of not less than 2 days for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is simultaneously functioning as specified. A report shall be prepared for each desiccant system, including the information outlined below. Data for the tests shall be taken at least three different times at outside wet-bulb temperatures which are at least 3 degrees C apart.

3.3.1 [AM0003] PassiveSolid (Wheel) Desiccant System:

- a. Date and outside weather conditions (at least two parameters to define the state of the outside air: DB, Gr./LB, Wb, relative humidity).
- b. The load on the system based on the following:
  - (1) CFM entering the system ([AM0003] SupplyProcess and RegenerationReturn).
  - (2) [AM0003] Outside Air Entering ConditionsProcess side-- entering air conditions (Db, Gr./LB).
  - (3) [AM0003] Chilled Water Coil Discharge ConditionsProcess side-- discharge air conditions (Db, Gr./LB).
  - (4) [AM0003] Supply AirProcess side-- post coolant capacity (tons).
  - (5) [AM0003] Return AirRegenerator side-- entering air conditions (Db, Gr./LB).
  - (6) [AM0003] Exhaust Air Regenerator side-- discharge air conditions (Db, Gr./LB).
  - (7) [AM0003] Hot Water Coil CapacityRegenerator side-- heat source capacity (Btu/hr).
  - (8) Running current, voltage and proper phase sequence for each phase of all motors.
  - (9) The actual on-site setting of all operating and safety controls.

## 3.4 PIPE COLOR CODE MARKING

Color code marking of piping shall be as specified in Section 09900 [AM0002] PAINTS AND COATINGS PAINTING, GENERAL.

## 3.5 INSPECTIONS

The manufacturer of the liquid desiccant system shall supply, free of charge, testing of solution samples sent to them by the customer every two months for the life of the equipment. The manufacturer of each type system shall inspect the systems after one year of operation to insure the systems are operating properly.

## 3.6 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 2 days. The representative shall advise on the proper operation and servicing of the equipment and make any adjustments necessary to insure full compliance with design criteria.

## 3.7 CLEANING AND ADJUSTING

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 the setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.8 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 4 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.

### 3.9 SERVICE CONTRACT

Contractor shall provide a five (5) year, unconditional maintenance contract for the Desiccant cooling system (symbol ERU) to include the [AM0003] passivedesiccant wheel, lubrication, [AM0002] fansfan, belts, motors, VFD, dampers, coils, and filters as required for periodic replacement.

### 3.10 [AM0002] FRAMED CHARTS AND GRAPHICS

Install framed charts and graphics with a glass cover on the wall of the mechanical room. The chart and graphics shall indicate all control components contained within the unit and its associated location. Nominal operating temperatures shall be identified on the graphics and listed in the chart as a function of the Outside Air and Return/Exhaust Air. The chart and graphics shall be presented in a manner that the maintenance personnel can use them to calculate and determine Supply Air to coils and other factors needed to verify performance of the unit without the need of a computer interface.

-- End of Section --

## SECTION 15974

## BUILDING AUTOMATION &amp; CONTROL SYSTEMS FOR LACKLAND AFB

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AIR MOVEMENT AND CONTROL ASSOCIATION, INC. (AMCA)

AMCA 500 1991 Test Methods for Louvers, Dampers and Shutters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND  
AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135 (1995) A Data Communication Protocol for Building Automation and Control Networks (BACnet)

## CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15 (1996) Radio Frequency Devices

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEE 142 (1991) Recommended Practice for Grounding of Industrial and Commercial Power Systems

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS (1993) Industrial Controls and Systems

NEMA 250 (1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1996) National Electrical Code

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL  
ASSOCIATION, INC. (SMACNA)

SMACNA-07

Ref Title

## UNDERWRITERS LABORATORIES (UL)

UL 506	(1994) (R 1993) Specialty Transformers
UL 916	(1994) Energy Management Equipment
UL 1449	(1996) Transient Voltage Surge Suppressors

## 1.2 SYSTEM DESCRIPTION

The Building Automation & Control System (BACS) shall utilize intelligent distributed control modules which communicate over a controller network in accordance with ANSI/ASHRAE 135, herein after referred to as "BACnet". The system shall provide the Direct Digital Control (DDC), Energy Management, and Building Automation functions for complete operation of heating, ventilating and air conditioning (HVAC) systems. Provide new BACS consisting of Notebook computers, DDC controllers, routers, Local Area Networks (LANs), software, and associated equipment and accessories using BACnet as the native communication protocol. The system is to control all mechanical equipment, including [AM0005] Air Handling Unit, Energy Recovery Unit, pumps, boilers and chillers (fan coil units shall have stand alone controls and not be interfaced into the building control system)~~terminal-unit equipment (fan coil units, etc.),~~ fans, pumps, central plant machinery and other specified equipment, directly without intervening electric, analog electronic, or pneumatic controls. A non-BACnet system meeting the functional requirements of this Specification shall be an acceptable alternative; the non-BACnet system shall include bi-directional protocol translators (gateways) that convert the non-BACnet system communication protocol to the BACnet protocol which will interoperate with BACnet Ethernet over twisted pair 10BaseT and Fiber Optic cabling systems. [AM0002] The BACS shall be compatible with and communicate with the existing Johnson Controls Metasys. Furnish and install the NCU and DX9100 controller as manufactured by Johnson Controls for compliance and interface.

## 1.2.1 Basic Features

## 1.2.1.1 System Hardware

All hardware Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the U.L. standard for safety 916, with integral labels showing rating. All hardware complies with Code of Federal Regulation 47 CFR 15, Radio Frequency Devices.

## 1.2.1.2 Fully Programmable

System designed for high-speed data processing; fully programmable, using advanced graphical programming tools.

## 1.2.1.3 Communications Network

The communication network between controllers utilize BACnet over EIA-485 MS/TP, at least 76 Kbaud, and/or BACnet over ARCNET 156 Kbaud at the Data Link Layer.

#### 1.2.1.4 System Auto-restart

Auto-restart of complete system, including DDC controllers, network controllers and routers, without operator intervention, on resumption of power after a power failure.

#### 1.2.1.5 Zone Control Functions

Zone by zone DDC control of space temperature, scheduling, optimum starting, equipment alarm reporting, and override timers for after-hours usage. A zone is the area served by one controller for each terminal unit.

### 1.3 SUBMITTALS

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

#### SD-01 Data

##### Equipment Data; G

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 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, but not be limited to, the following:

- a. BACnet routers, converters and gateways.
- b. Auto-dial/auto-answer modems.
- c. Notebook computer(s).
- d. Hand-held terminal(s).
- e. Digital controllers and controller cabinets.
- f. Input and output (I/O) devices.
- g. Surge and transient protection.

##### Software; G

Descriptions of software, including but not limited to, operating systems and utility software; diagnostic routines; DDC software; communications programs; and user interface software.

##### Training; G

A training course in the maintenance and operation of the BACS, approved 60 days prior to the start of training. The training

shall be oriented to the specific systems being installed under this contract. One training manual shall be furnished for each trainee, plus two additional copies delivered for archival storage at the project site. The manual 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 delivered 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.

#### SD-02 Drawings

##### System Drawings; G.

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, controller/control 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 controller 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, controller, 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. Controller/control panel installation, block diagrams, and wiring diagrams.

- f. Controller/control panel 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 each actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive-positioner ranges, location 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.

#### Site Testing; G.

Two 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; G.

Two copies of the test procedures for the performance verification 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; G.

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.

Two 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-03 Product Data

Equipment Data; G.

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 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 but not limited to the following:

- a. BACnet routers, converters and gateways.
- b. Auto-dial/auto-answer modems.
- c. Notebook computer(s).
- d. Hand-held terminal(s).
- e. Digital controllers and controller cabinets.
- f. Input and output (I/O) devices.
- g. Surge and transient protection.

Software; G.

Descriptions of software, including but not limited to operating systems and utility software; diagnostic routines; DDC software; communications programs; and user interface software.

#### SD-06 Test Reports

Test Reports; G.

Two 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 Report; G.

Two copies of the performance verification 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; G.

Two copies of the calibration, adjustment and commissioning report which shall include setpoints and proportional, integral and derivative mode constant settings, calibration data for all I/O devices, and all the data resulting from adjusting the control system devices and commissioning HVAC control systems.

#### SD-10 Operation and Maintenance Data

Technical Data Package; G.

Operation and maintenance data in manual format. Final copies of the manuals bound in hardback, loose leaf binders, at least 2 weeks prior to training course. 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; G.

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; G.

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; G.

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; G.

Four 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; G.

Four 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 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 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.

### 1.5.2 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.

### 1.5.3 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.

### 1.5.4 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.

#### 1.5.5 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 5 operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. The course shall be taught at the project site for a period of 10 training days. A training day is defined as 8 hours of classroom instruction, including breaks and lunch time, 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, Some experience using Windows-based software, 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 Operator Training

The operator's course shall be taught for a total of 7 training days. Training shall be classroom, but have hands-on operation of similar digital controllers. Upon completion of this course, students should be fully proficient in the operation of each system function. This course shall include but not be limited to:

- a. Theory of operation
- b. Hardware architecture
- c. Operation of the system
- d. Operator commands
- e. Control sequence programming
- f. Data base entry
- g. Reports and logs
- h. Alarm reports
- i. Diagnostics

### 1.6.3 Maintenance Personnel Training

a. The system maintenance course shall be taught for a period of 3 training days. The course shall include but not be limited to:

- (1) Physical layout of each piece of hardware.
- (2) Troubleshooting and diagnostics procedures.
- (3) Repair instructions.
- (4) Preventive maintenance procedures and schedules.
- (5) Calibration procedures.

b. Troubleshooting, checkout and calibration of the working system shall be accomplished in a classroom setting and repeated on-site.

## 1.7 QUALITY ASSURANCE

### 1.7.1 Standard Products

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. Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such product, using similar materials, design and workmanship. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components.

### 1.7.2 Single-source Responsibility

The HVAC Controls Contractor shall have single-source responsibility for the complete acquisition, installation, and proper operation of the BACS. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

### 1.7.3 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 the work.

### 1.7.4 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, and shall

furnish all work necessary to meet such conditions.

## PART 2 PRODUCTS

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

#### 2.1.1 Conformance to BACnet

All controllers and network devices shall conform to the BACnet protocol. Each type device shall have a protocol implementation conformance statement (PICS) that identifies all of the portions of BACnet that are implemented in each device. Each PICS shall include device description and manufacturer, supported functional groups, supported application services and object types, data link layer options, and supported segmented requests and responses.

#### 2.1.2 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 with NEMA 250 unless otherwise shown. Control panels shall have ambient condition ratings of plus 2 to 50 degrees C and 10 to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 2 to 63 degrees C. I/O devices shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

#### 2.1.3 Multiple Controller Requirement

Where the system to be controlled by the BACS is located in multiple mechanical rooms, each mechanical room shall have at least one digital controller. Digital controllers shall be located in the same room as the equipment being controlled or in an adjacent space which has direct access to the equipment room. Each mechanical system shall have its own dedicated controller or group of controllers.

#### 2.1.4 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device unique identifiers as shown shall be engraved or stamped characters. Nameplates shall be permanently attached to HVAC/DDC control panel doors. For each field device and equipment item not in a finished area, a plastic or metal tag with equipment name and point identifier shall be attached. Each air flow measurement station shall have a tag showing flow rate range for signal output range, duct size and identifier as shown.

### 2.2 BACNET ROUTERS, CONVERTERS, AND GATEWAYS

#### 2.2.1 Routers

BACnet routers shall be conformance class 6 devices interconnecting two or more BACnet networks to form a internetwork. Routers shall have the routing functionality of interconnecting BACnet Ethernet high speed LAN, to

BACnet MS/TP LAN or BACnet ARCNET high speed LAN. BACnet PTP (RS-232 point-to-point) communication shall be available on routers by including modems; PTP/modem shall operate under the BACnet half-router communication protocol.

#### 2.2.2 Converters

A converter shall be provided to interface notebook computers and hand held terminals from its RS-232 serial port to system controllers on the BACnet LANs (Ethernet, MS/TP, ARCNET).

#### 2.2.3 Gateways

BACnet gateways shall be microprocessor based protocol translators performing bi-directional translation between BACnet and non-BACnet protocols. Gateways shall be BACnet conformance class 6 devices. Each gateway shall have a database containing local and global data. Local data shall be unique from gateway to gateway, and global data shall be the same type in every gateway. Implement analog and digital point data, descriptors, time and trend schedule data, and network data for all mechanical/electrical systems connected to the DDC system. Points shall be viewed and commanded on the BACnet side of the gateway in the same manner as those points connected to non-BACnet controllers. Multiple gateways shall be provided as required to meet or exceed the capacity of the DDC system. Gateway features and connections shall include but not limited to the following:

- a. Full and transparent translation of any point data on the non-BACnet LAN to the BACnet format.
- b. Communications and alarm processing software.
- c. Operating system and utility software.
- d. Nonvolatile memory/battery-backed RAM for storage of system items.
- e. Built-in 10BaseT Interface for communications via BACnet Ethernet LAN.
- f. RS-232 port for notebook computer, or modem to remote site.
- g. Configuration tool software, a Windows-based program to create device application and data files that define controllers and points, and provide point data information between the two networks.

#### 2.3 DIRECT DIGITAL CONTROL (DDC) DEVICES

DDC controllers shall be stand-alone microprocessor-based devices with sufficient memory and point capacity to perform specified functions and operations. Controllers shall be BACnet conformance class 3 or class 4 devices. Total number of I/O hardware points connected to a single digital controller shall not exceed 85 percent of the controller's point capacity; I/O expansion units and multiplexing of I/O are not permitted. All digital controllers shall operate within limit ratings of 35 to 120 degrees F and

10 percent to 95 percent relative humidity, noncondensing. Provide real time clock with each controller on the highest level LAN. Backup power shall be provided to each controller's clock and random access memory (RAM) by a battery or capacitor with sufficient capacity to maintain operation for a minimum of 72 hours during a line power outage. Closed-loop control functions shall include proportional, proportional plus integral, and proportional plus integral plus derivative (PID) control capability. Controllers shall have communication ports for connection to BACnet MS/TP or ARCNET LAN.

#### 2.3.1 I/O Functions

I/O functions shall be integral to each digital controller, and shall include the following:

a. Analog Inputs: Allowable input types are 2 or 3 wire 1000 ohm (or higher) platinum resistance temperature detectors (RTDs), stable 10,000 ohm thermistors, and 4 to 20 mA dc. Thermistor and direct RTD inputs must have appropriate conversion curves stored in controller software or firmware. Analog to digital (A/D) conversion shall be a minimum of 10 bits resolution.

b. Digital Inputs: Digital inputs shall sense open/close, on/off, or other two state indications. Input device contacts shall be nonpowered.

c. Pulse Accumulator: The pulse accumulator function shall have the same characteristics as the digital input function, except that, in addition, a buffer shall be provided to totalize pulses and allow for interrogation by the controller. The pulse accumulator shall accept rates up to 10 pulses per second.

d. Analog Outputs: Analog outputs shall be 2-10 Vdc or 4-20 mA dc. Digital-to-analog (D/A) conversion shall be a minimum of 8 bits resolution.

e. Digital Outputs: Digital outputs shall provide contact closures for momentary and maintained operation of output devices. Outputs shall have a minimum closure duration of 0.1 second with contacts rated for a minimum of 1 ampere at 24 Vac.

#### 2.3.2 Digital Controller Cabinet

Each digital controller cabinet shall protect the controller from dust and be rated NEMA 1, unless specified otherwise. Controller cabinets or enclosures shall be lockable with common keying. Provide door switch wired to input of controller for intrusion alarm annunciation. A 120 Vac, 15 amp, 60 Hz duplex outlet shall be provided for each separate location of controller cabinet on the highest level LAN. The duplex outlet shall be on a separate circuit from the digital controllers.

#### 2.3.3 Terminal-Unit Controls

Terminal-unit controllers shall be manufactured by the same company as the

digital controllers. Unit controllers shall be conformance class 3, stand-alone, microprocessor-based controllers connected to a lower level LAN; controllers shall communicate with the digital controllers. Unit controllers may deviate from stand-alone only in receiving energy management and time information from a stand-alone digital controller. Unit controllers may be used for the control of variable air volume (VAV) boxes, fan coil units, and heat pumps. Controls for VAV boxes shall consist of a velocity-sensing device in the primary air entering the box, a room temperature sensing element, a damper actuator, and a unit controller; a duct pressure switch shall be included when VAV box is provided with recirculation fan. Each controller shall operate the damper for cooling and the recirculation fan and duct coil for heating. Terminal units shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

#### 2.4 DDC SOFTWARE

Each digital controller shall contain an operating system, self-test diagnostic routines, start-up software, and application programs and routines as specified. The operating system shall control and schedule controller activities, and maintain a point database that includes all parameters and constraints. Controllers shall automatically start-up on return of power after a failure, and previous operating parameters shall exist or shall be automatically downloaded from a controller or host workstation on the higher level LAN. In addition to specified programs and routines, provide software in respective controllers required to perform the indicated "control sequences of operation". The sequence of control shall be written to include all conventional control operations (e.g. temperature and pressure control loops), time event operations, energy management functions (night setback, reset schedules, and optimum start-stop routines), demand limiting, safeties, and emergency conditions.

##### 2.4.1 Database Modification

Software shall be provided to modify the control program database. Database modification shall be accomplished through connected computer or hand-held terminal or through a keypad integral to the controller.

##### 2.4.2 Runtime Accumulation

Resettable runtime accumulation shall be provided for each controlled electrical motor.

##### 2.4.3 Scheduled Start-Stop

Programs shall be provided to start and stop equipment based on time-of-day schedules for each day of the week, and on holiday schedules. Programs shall automatically adjust for leap years, and make daylight savings time and standard time adjustments.

##### 2.4.4 Optimum Start-Stop

Programs shall be provided to start and stop equipment as specified for the scheduled start-stop program, but shall include a sliding schedule based on

indoor and outdoor air conditions. The program shall take into account the thermal characteristics of the structure, indoor and outdoor air conditions using predictive software to determine the minimum time of HVAC system operation required to satisfy space environmental conditions at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end.

#### 2.4.5 Demand Limiting

Software shall be provided to shed electrical loads when the building or base is near peak demand. The program shall continuously monitor pulses from a building's electric meter and with predictive software, calculate a predicted power demand. When the predicted demand exceeds a preset target, the program shall shed loads on a prescheduled priority basis to reduce the connected load before the actual peak exceeds the target. Program demand limiting routines into the sequence of control.

#### 2.4.6 Point Override

I/O and virtual points shall be able to be software overridden in the software and commanded to any possible value.

#### 2.4.7 Alarming

I/O points and virtual points shall be alarmable. Alarm limits shall be adjustable on analog points.

#### 2.4.8 Messages

Messages shall be operator defined and assigned to alarm points. Messages shall be displayed when a point goes into alarm.

#### 2.4.9 Trending

DDC system shall have the capability to trend I/O and virtual points. Points associated into groups. A trend report may be set up for each group. The period between logging consecutive trend values shall range from one minute to 60 minutes as a minimum. Trend data type shall be selectable as either averages over the logging period or instantaneous values at the time of logging. The minimum number of consecutive trend values stored at one time shall be 30 per variable. When trend memory is full, the most recent data shall overwrite the oldest data. Trend data shall be capable of being uploaded to workstation computer. Trend data shall be available on a real time basis; trend data shall appear either numerically or graphically on a connected notebook computer screen as the data is being processed from the DDC system data environment. Trend reports shall be capable of being uploaded to workstation disc and archived.

#### 2.4.10 Status Display

Current status of I/O and virtual points shall be displayed on command. Points shall be associated into functional groups, such as all the I/O and virtual points associated with control of a single air handling unit, and displayed as a group, so the status of a single mechanical system can be

readily checked. A group shall be selectable from a menu of groups having meaningful names; such as AHU-1, Boiler System, Chiller System, and other such names.

#### 2.4.11 Power Loss

In event of a power outage, each controller shall assume a disabled status and outputs shall go a user-definable state. Upon restoration of power, DDC system shall perform an orderly restart, with sequencing of outputs.

#### 2.4.12 Program Transfer

Control programs and database shall be capable of being down-loaded from workstation computer to controllers and uploaded to workstation from controllers. Every digital controller in the DDC system shall be capable of being downloaded and uploaded through a single controller on the highest level LAN.

### 2.5 PORTABLE COMPUTERS AND TERMINALS

The BACS primary operator/maintenance terminals shall be notebook computers and hand-held terminals used to perform command entry, database and alarm management, system monitoring and control setpoint adjustment, and other related functions.

#### 2.5.1 Notebook Computer

Notebook computer with instruction manual and universal carrying case shall be provided. Computer shall include but not limited to:

- a. 1.7 GHz or faster Pentium III or IV Processor, 256MB RAM.
- b. 40GB Hard Drive, 40X CD-ROM Drive, 3.5" Diskette Drive.
- c. 14" Color Display, Parallel and Serial Ports.
- d. Windows 2000 or Windows XP Operating System.
- e. Network Management, Communications and Utility Software.

#### 2.5.2 Hand-Held Terminals

Hand-held terminal or communications-and-programming device with instruction manual and direct connection cable to communicate with controllers shall be provided. Hand-held terminal shall connect to high and low level LAN controllers directly or to a jack at room-temperature-sensing element locations. Provide one additional hand-held device, manual, and cable per 60 controllers. Notebook computers with the required functionality may be provided as an alternative to hand-held terminals.

### 2.6 DAMPERS

#### 2.6.1 Damper Assembly

A single damper section shall have blades no longer than 1,220 mm and shall be no higher than 1,830 mm. Maximum damper blade width shall be 200 mm. 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. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same section will not be located directly in the air stream. Damper axles shall be 13 mm (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 1.01 mm water gauge at 5 meters per sec (0.04-inch water gauge at 1,000 fpm) in the wide-open position. Frames shall not be less than 50 mm in width. Dampers shall be tested in accordance with AMCA 500.

#### 2.6.1.1 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.

#### 2.6.1.2 Damper Types

Dampers shall be parallel or opposed blade type. Parallel blades shall be used for on-off dampers and opposed blades shall be used for modulating dampers.

#### 2.6.2 Outside-Air, Return-Air, and Relief-Air Dampers

The 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 0.0968 cubic meter per sec per square meter at 100 mm (20 cfm per square foot at 4 inches) water gauge static pressure when closed. Seals shall be suitable for an operating temperature range of -40 to +93 degrees C. Dampers shall be rated at not less than 10 meters per sec air velocity.

#### 2.6.3 Mechanical and Electrical Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of (0.406 cubic meter per sec per square meter at 100 mm) water gauge static pressure when closed. Dampers shall be rated at not less than 7.6 meters per sec (1500 fpm) air velocity.

### 2.7 AUTOMATIC CONTROL VALVES

#### 2.7.1 Valve Assembly

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 860 KPa (125 psig) working pressure of 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be .01 percent of rated Cv.

#### 2.7.2 Butterfly-Valve Assembly

Butterfly valves shall be threaded lug type suitable for dead-end service, and for 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 -30 to + 120 degrees C . Valves shall have a manual means of operation independent of the actuator.

#### 2.7.3 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

#### 2.7.4 Three-way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

#### 2.7.5 Fan Coil -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.

#### 2.7.6 Valves for Chilled-Water Service.

Bodies for valves 38 mm and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 mm to 76 mm inclusive shall be of brass, bronze or iron. Bodies for 50 mm (2-inch) valves shall have threaded ends. Bodies for valves from 63 mm to 76 mm shall have flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal valve trim shall be brass or bronze except that valve stems may be type 316 stainless steel. Valves 100 mm (4 inches) and larger shall be butterfly valves.

#### 2.7.7 Valves for Hot-Water Service Below 120 degrees C

Bodies for valves 38 mm (1-1/2 inches) and smaller shall be brass or bronze, with threaded or union ends. Bodies for 50 mm (2-inch) valves shall have threaded ends. Bodies for valves from 2 inches to 3 inches inclusive shall be of brass, bronze, or iron. Bodies or valves 100 mm (4 inches) and larger shall be iron. Bodies for valves 50 mm (2-inch) inches and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 percent to 125 percent of the Cv shown. Internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 100 degrees C shall be type 316 stainless steel. Internal trim for valves controlling water 100 degrees C or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature or 120

degrees C or 50 degrees F above the system design temperature, whichever is higher. Valves 100 mm and larger shall be butterfly valves.

#### 2.7.8 Valves for High-Temperature Hot-Water Service Above 250 Degrees F

Valve bodies shall be rated ANSI Class 300, as in ASME B16.34. Valve and actuator combination shall be normally closed. Bodies shall be carbon steel, globe type with welded ends on valves 25 mm (1-inch) and larger. Valves smaller than 25 mm (1-inch) shall have socket-weld ends. Packing shall be virgin polytetrafluoroethylene (PTFE). Valve Cv shall be within 100 percent to 125 percent of the Cv shown.

### 2.8 ACTUATORS

#### 2.8.1 General Requirements

Actuators shall fail to their spring-return positions as shown 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. Pneumatic actuators shall be rated for 172 KPa (25 psig) operating pressure except for high-pressure cylinder-type actuators. Actuators shall be pneumatic, electric or electronic as shown.

#### 2.8.2 Damper Actuators

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. The actuators shall be provided with mounting and connecting hardware.

#### 2.8.3 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.

### 2.9 INPUT AND OUTPUT (I/O) DEVICES

#### 2.9.1 Measurements

Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for an output of 4 to 20 mAdc:

- a. Room/space temperature, 4 to 38 degrees C .
- b. Duct temperature, -18 to +65 degrees C .
- c. Chilled-water temperature, -2 to +38 degrees C .
- d. Heating hot water temperature, 4 to 115 degrees C .
- e. Outside-air temperature, -18 to +115 degrees C .
- f. Relative humidity, 5 to 95 percent.
- g. Fluid and gas pressure or differential pressure range: select

minimum required for the application.

#### 2.9.2 Resistance Temperature Detectors (RTDs)

RTD sensors shall be 1000 ohm, or higher, platinum elements that are compatible with the digital controllers. Sensors shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 0 degrees C . Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative. When 2 or 3 wire RTDs are connected directly to the controller, keep lead resistance error to 0.14 degree C (0.25 degree F) or less. Total error for a RTD circuit shall not exceed 0.5 degree F, which includes sensor error, lead resistance error or 4 to 20 milliampere transmitter error, and A/D conversion resolution error.

Provide manufacturer documentation and the Contractor's engineering calculations which support that the proposed RTD circuit will have a total error of 0.28 degrees C or less for the specified application. Provide 4 to 20 milliampere transmitters for RTDs where digital controllers do not meet temperature resolution requirement of 0.14 degree C (0.25 degree F) or do not support direct connection of RTDs.

#### 2.9.3 Thermistors

Precision thermistors may be used in temperature sensing applications below 93 degrees C . Sensor accuracy over the application range shall be 0.20 degrees C (0.36 degrees F) or less between the range of 0 to 63 degrees C .

Sensor manufacturer shall utilize 100 percent screening to verify accuracy. Thermistors shall be pre-aged, and inherently stable. Stability error of the thermistor over five years shall not exceed 0.14 degree C (0.25 degree F) cumulative. Sensor element and leads shall be encapsulated. Bead thermistors are not allowed. A/D conversion resolution error shall be kept to 0.05 degree C (0.1 degree F) . Total error for a thermistor circuit shall not exceed 0.28 degrees C , which includes sensor error and digital controller A/D conversion resolution error. Provide thermistor and digital controller manufacturer documentation and the Contractor's engineering calculations which support that the proposed thermistor input circuit will have a total error of 0.28 degrees C or less.

#### 2.9.4 Temperature Sensor Details

a. Room Type: Conceal element behind protective cover matched the room interior.

b. Duct Averaging Type: Continuous averaging RTDs for ductwork applications shall be 1 foot in length for each 0.3716 square meter (4 square feet) of ductwork cross-sectional area with a minimum length of 1,830 mm . Probe type duct sensors of 25 mm length minimum are acceptable in ducts 3,660 mm square and less.

c. Immersion Type: Total immersion depth (76 mm to 150 mm ) as required for the application for use with thermowells, unless otherwise indicated.

d. Outside Air Type: Sensor shall have weatherproof housing, and

sunshield to minimize solar effects. Mount element at least 76 mm from building outside wall.

#### 2.9.5 Transmitters

Transmitters shall have 4 to 20 ma output linearly scaled to the temperature, pressure, humidity, or flow range being sensed. Transmitter shall be matched to the sensor, factory calibrated, and sealed. Total error shall not exceed 0.1 percent of 20 milliampere (0.02 milliampere) at any point across the 4 to 20 ma span. Supply voltage shall be 24 Vdc. Transmitters shall have noninteractive offset and span adjustments. For temperature sensing, transmitter stability shall not exceed 0.05 degrees C (0.09 degree F) a year.

#### 2.9.6 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 2-inch lagging neck and extension-type well, and inside diameter and insertion length as required for the application.

#### 2.9.7 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 sunshields shall be PVC, or painted white or shall be unpainted aluminum.

#### 2.9.8 Relative Humidity Instruments

The instrument (humidity sensor and transmitter) shall be a 2 wire loop-powered device and have an output of 4 to 20 mAdc proportional to 5 to 95 percent relative humidity input. Accuracy shall be plus or minus 2 percent of full scale within the range 20 to 80 percent relative humidity. Sensing element shall be chilled mirror type, polymer, or thin film polymer type. Supply voltage shall be 24 Vdc. Transmitter shall include offset and span adjustments. Provide instrument with weather-proof housing for outdoor applications.

#### 2.9.9 Pressure and Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument overpressure rating shall be 300 percent of the operating pressure. Sensor-transmitter assembly accuracy shall be plus or minus 1 percent of full scale. The transmitter shall be a 2 wire, loop-powered device and have an output of 4 to 20 mAdc proportional to the input pressure range. Each transmitter shall have offset and span adjustments.

#### 2.9.10 Flow Switches

Flow switches shall have a repetitive accuracy of plus or minus 1 percent of full scale. Switch actuation shall be adjustable over the flow operating flow range. The switch shall have a snap-action Form C contact

rated for the application.

#### 2.9.11 Pressure and Differential Pressure Switches

Each switch shall have an adjustable trip setpoint, and single pole double throw contacts rated for the application. Provide taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure; fittings shall be of the angled-tip type with tips pointing into the air stream. Switches shall withstand pressure surges up to 150 percent of rated pressure. Each pressure switch shall be selected so that operating pressure trip point is approximately midpoint of pressure switch adjustable range. Repetitive accuracy shall be 2 percent.

#### 2.9.12 Insertion Freeze Protection Switch

Electric switch shall be capillary type. Provide special purpose insertion thermostats with flexible elements a minimum of 6100 mm in length for coil face areas up to 3.7 square meters. Switch contacts shall be rated for motor starter circuit voltage being interrupted. Switch shall be equipped with auxiliary set of contacts for input of switch status to digital controller. Provide additional elements or longer elements for larger coils at the rate of 305 mm length of element per 0.37 square meter of coil. Serpentine entire airflow. A freezing condition at 460 mm increments along the sensing element shall activate the thermostatic switch. Switch shall require manual reset after activation.

#### 2.9.13 Current-Sensing Switches

Current-sensing switches shall be of a design that provides a normally-open single pole single throw contact rated for the application. Switches shall be single unit construction with provisions for firm mounting. Each current-sensing switch shall have a single thru-hole for passage of current-carrying conductors, selected 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.

#### 2.9.14 Energy Metering Devices

##### 2.9.14.1 Electric Meters

Watt-hour meters with pulse initiators shall be as specified in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Pulse initiator shall be connected to respective digital controller.

##### 2.9.14.2 Gas Meters

Gas meters with pulse switches shall be as specified in Section 02556 GAS DISTRIBUTION SYSTEM. Pulse switch shall be connected to respective digital controller.

##### 2.9.14.3 Water Meters

Water meters with pulse switches shall be as specified in Section 02510 WATER DISTRIBUTION SYSTEM. Pulse switch shall be connected to respective

digital controller.

#### 2.9.15 Pneumatic to Electronic Transducers

Pneumatic-to-electronic transducers shall convert 3 to 15 psig pressure input signal to a 4 to 20 mA<sub>dc</sub> output signal. Supply voltage shall be 24 V<sub>dc</sub>. Accuracy shall be 1 percent or better. Linearity shall be 0.1 percent.

#### 2.9.16 Thermostats

Thermostat ranges shall be selected so that the setpoint is adjustable between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or low-voltage electric. Modulating room and modulating capillary 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 -15 to -13 degrees C for each output. Room thermostats shall be enclosed with separate locking covers (guards). Low-temperature-protection thermostats shall be low-temperature safety thermostats, with normally-open and normally-closed contacts and a 6100 mm element which shall respond to the coldest 460 mm segment.

#### 2.9.17 Control Relays

Relays shall be double pole, double throw (DPDT), UL listed, with contacts rated for the application, and enclosed in a dustproof enclosure. Equip with a light indicator which is lit when coil is energized and is off when coil is not energized. Relays shall be socket type, plug into a fixed base, and be replaceable without need of tools or removing wiring.

#### 2.9.18 Humidity Sensors

Humidity sensors shall be of design for duct mounting and utilizing permanent, calibratable sensor unit. Chemical or other devices which must be replaced from time to time are not acceptable. Range shall be 0-100% RH, accuracy +/- 2%, response time approximately 15 seconds, temperature coefficient and linearity +/- 0.1 degrees C, with transmitter compatible with the system.

### 2.10 INDICATING DEVICES

#### 2.10.1 Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 228 mm (9-inch) scale. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern. All stems shall have expansion heads as required to prevent breakage at extreme temperatures; the space between bulb and stem shall be filled with a heat-transfer medium. Non-averaging air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism. Averaging air-duct thermometers shall have no less than 89 mm dial, with black legend on white background, and pointer traveling through a

270-degree arc. Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Select thermometer ranges so normal temperatures are approximately equal to midpoint readings on the scale, unless otherwise specified.

#### 2.10.2 Pressure Gauges

Gauges shall be 50 mm (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 2 percent of scale range. Select gauge ranges so normal pressures are approximately equal to the midpoint readings on the scale, unless, otherwise specified. Gauges shall conform to ANSI/ASME B40.1. Provide gauges as specified for the following applications:

a. Hydronic System: Gauges for hydronic-system applications shall have ranges and graduations as shown.

b. Low Differential Pressure: Gauges for low differential-pressure measurements shall be 114 mm (4-1/2-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.

#### 2.11 ELECTRICAL POWER AND DISTRIBUTION

Wiring and cable circuits shall be provided for all DDC apparatus, including wiring to transformer. Provide circuit and wiring protection in accordance with NFPA 70. A source 120 volts or less, 60 hz, two-pole, three wire with ground shall be provided. Devices shall be UL listed or FM approved. All electrical, electronic, and electro-pneumatic devices not located within a DDC panel shall have an enclosure NEMA 1 in accordance with NEMA 250 unless otherwise shown.

##### 2.11.1 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

##### 2.11.2 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable panel and rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

##### 2.11.3 Transformers

Transformers shall conform to UL 506. Power digital controllers on the highest level LAN from dedicated circuit breakers. Transformers for digital controllers serving terminal equipment on lower level LANs shall be fed from the fan motor leads or fed from the nearest distribution panel board or motor control center, using circuits provided for the purpose.

Provide a fuse cutout on the secondary side of the transformer.

#### 2.11.4 Surge Protection

Surge and transient protection consist of devices installed externally to digital controllers.

##### 2.11.4.1 Power Line Surge Protection

Surge suppressors external to digital controller, shall be installed on all incoming AC power. Surge suppressor shall be rated by UL 1449, and have clamping voltage ratings below the following levels:

- a. Normal Mode (Line to Neutral): 350 Volts
- b. Common Mode (Line to Ground): 350 Volts

##### 2.11.4.2 Communications Line Surge Protection

Protected from surges. metal oxide varistor (MOV) protection, rated for the application, shall be installed at the equipment. Additional protection, gas tubes rated for the application, shall be installed within 915 mm of the building cable entrance.

##### 2.11.4.3 Sensor and Control Wiring Surge Protection

Controllers shall have sensor and control wiring surge protection with optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

#### 2.11.5 Wiring

##### 2.11.5.1 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be insulated copper 1.195 mm (18 AWG) minimum and shall be rated for 300-volt service.

##### 2.11.5.2 Wiring for 120-volt Circuits

Wiring for 120-volt circuits shall be 2 mm (14 AWG) minimum and shall be rated for 600-volt service.

##### 2.11.5.3 Analog Signal Wiring Circuits

Analog signal wiring for analog inputs and analog outputs shall be 1.195 mm (18 AWG) , single or multiple twisted pair. Each pair shall be 100 percent shielded, and have 1 mm (20 AWG) drain wire. Each wire shall have insulation rated to 300 volts.

##### 2.11.5.4 Instrumentation Cable

Instrumentation cable shall be 1.195 mm (18 AWG) , stranded copper, single or multiple-twisted, minimum 50 mm lay of wist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 1 mm

(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 1 mm (20 AWG) tinned-copper cable drain wire, and overall cable insulation.

## 2.12 FIRE PROTECTION DEVICES

Smoke detectors shall be as specified in Section 13851 FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE.

## 2.13 FIBER OPTIC (FO) CABLE & APPARATUS

### 2.13.1 FO Cable

The FO cable shall be totally dielectric, with a minimum of 12 optical fibers unless otherwise indicated. The fibers shall be multimode, graded index, solid glass waveguides, and shall have a nominal core diameter of 62.5 micrometers. The outside diameter of the glass-cladded fiber shall be nominally 125 micrometers, and shall be concentric with the fiber core. FO cable for outdoor applications shall be of loose tube construction with a maximum of four fibers per tube. Cable may be of loose tube or tight buffer construction for indoor applications. Plenum cable shall meet UL 910, and riser cable shall meet UL 1666. FO cable shall be continuous with no factory splices.

### 2.13.2 FO Connectors

FO connectors shall be ST style, multimode, field installable, self-aligning and centering. Provide ST style connectors for FO cables and patchcords. Connectors shall not require polishing or epoxy during installation, with no compromise in performance.

### 2.13.3 Fiber Interconnect Center

The fiber interconnect center shall be an enclosure unit designed to terminate, store, and protect up to 24 FO connections. Equip unit with 24 ST style multimode adapters. Interconnect center design features shall include easy access to individual connections, ample room for feed-through cables, and strain-relief provisions for multiple cables within unit. Furnish labels to document fiber connections and routing.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Perform installation under supervision of competent technicians regularly employed in the installation of DDC systems. Provide components for a complete and operational DDC system.

#### 3.1.1 Wiring Criteria

- a. Input/output identification: Permanently label each field wire at each end with the identification specified.

b. Surge Protection: Install surge protection no more than three feet from where communication cable enters building.

c. Grounding: Ground controllers and cabinets to a good earth ground. Ground controller to a ground in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Grounding of the green ac ground wire, at the breaker panel, alone is not adequate. Run metal conduit from controller panels to adequate building grounds. Ground sensor drain wire shields at controller end.

d. Signal Wiring: Install analog signal wiring in conduit separate from AC power circuits.

e. Contractor is responsible for correcting all associated ground loop problems.

### 3.1.2 Digital Controllers

a. Do not divide control of a single mechanical system such as an air handling unit, boiler, chiller, or terminal equipment between two or more controllers. A single controller or master/slave controllers shall manage control functions for a single mechanical system.

b. Provide digital control cabinets that protect digital controller electronics from dust, at locations shown on the drawings.

c. Provide a main power switch at each highest level LAN digital controller within controller cabinet.

d. No multiplexing of points is allowed.

### 3.1.3 Temperature Sensors

Provide temperature sensors in locations to sense the appropriate condition. Provide sensor where they are easy to access and service without special tools. Calibrate sensors to accuracy specified. In no case will sensors designed for one application be installed for another application such as replacing a duct sensor with a room sensor.

#### 3.1.3.1 Room Temperature Sensors

Provide on interior walls to sense average room temperature conditions. Avoid locations which may be covered by office furniture. Room temperature sensors should not be mounted on exterior walls when other locations are available. Mount center line of sensor at 5 feet above finished floor.

#### 3.1.3.2 Duct Mounted Sensors

a. Provide sensors in ductwork in general locations as indicated. Select specific sensor location within duct to accurately sense appropriate air temperatures. Do not locate sensors in dead air spaces or positions obstructed by ducts or equipment. Install gaskets between the sensor housing and duct wall. Seal duct and insulation penetrations.

b. String duct averaging sensors between two rigid supports in a serpentine position to sense average conditions. Thermally isolate temperature sensing elements from supports. Provide duct access doors to averaging sensors.

c. Locate freeze protection sensors in appropriate locations to sense lowest temperatures, to avoid potential problems with air stratification.

#### 3.1.3.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring temperatures in liquid applications or pressure vessels. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to effect proper flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermowells with thermal transmission material within the well to speed the response of temperature measurement. Provide wells with sealing nuts to contain the thermal transmission material.

#### 3.1.3.4 Outside Air Temperature Sensors

Provide outside air temperature sensor on north side of the building, away from exhaust hoods, air intakes and other areas that may affect temperature readings. Provide sunshields to protect outside air sensor from direct sunlight.

#### 3.1.3.5 Low Temperature Protection Temperature Switch

For each 40 square feet of coil-face area, provide a temperature switch to sense the temperature at the location shown. Provide temperature switch sensing element in a serpentine pattern.

#### 3.1.4 Damper Actuators

Actuators shall not be mounted in the air stream.

#### 3.1.5 Thermometers

Provide thermometers at locations indicated. Mount thermometers to allow readability when standing on the floor.

#### 3.1.6 Pressure Sensors

##### 3.1.6.1 Differential Pressure

a. General: Install pressure sensing tips in locations to sense appropriate pressure conditions.

b. Pumping Proof with Differential Pressure Switches: Install high pressure side between pump discharge and check valve.

### 3.1.7 Pressure Gages

Install pressure gages at locations indicated. Mount pressure gages to allow readability while standing on the floor.

### 3.1.8 Control Drawings

- a. Post laminated copies of record (as-built) control system drawings in each mechanical room.
- b. Provide 6 sets of record (as-built) drawings to the activity.

## 3.2 COMMISSIONING PROCEDURES

### 3.2.1 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.

#### 3.2.1.1 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 controller (such as starter auxiliary contacts, and external systems) may be simulated in steps 1, 2, and 3. With each operational-mode signal change, controller output relay contacts shall be observed to ensure that they function.

#### 3.2.1.2 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.

#### 3.2.1.3 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 controller 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-controller 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-controller 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.

#### 3.2.1.4 Insertion and Immersion Temperatures

Insertion temperature and immersion temperature sensing elements and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

#### 3.2.1.5 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller 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.

### 3.3 SITE TESTING

#### 3.3.1 General

a. Demonstrate compliance of the BACS with the contract documents.

Furnish personnel, equipment, instrumentation, and supplies necessary to perform site testing. Ensure that tests are performed by competent employees of the DDC system installer or the DDC system manufacturer regularly employed in the testing and calibration of DDC systems.

b. Tests are subject to oversight and approval by the Contracting Officer. The testing shall not be run during scheduled seasonal off-periods of heating and cooling systems. Performance verification test shall ensure proper execution of the sequence of operation and proper tuning of control loops.

c. Obtain approval of the plan for each phase of testing before beginning that phase of testing. Give to the Contracting Officer written notification of planned testing at least 30 days prior to test.

Notification shall be accompanied by the proposed test procedures. In no case will the Contractor be allowed to start testing without written Government approval of test procedures. The test procedures shall consist of detailed instructions for complete testing to prove performance of the heating, ventilating and air-conditioning system and digital control system. Conduct performance verification test during one week of continuous HVAC and DDC systems operation and before final acceptance of work.

#### 3.3.2 Performance Verification Test

Test procedures shall include tests outlined in the following paragraphs.

a. Check the operation of each output to verify correct operation.

Command digital outputs on and off. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA, measure and record commanded and actual output values. Document each command and

result for the test report.

b. With the digital controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for all modulating control valves and dampers. Include documentation in the test report.

c. Demonstrate that programming is not lost after a power failure, and digital controllers automatically resume proper control after a power failure.

d. Show that surge protection, meeting the requirements of this specification, has been installed on incoming power to the digital controllers and on communications lines.

e. Furnish the Government graphed trends to show the sequence of operation is executed in correct order. Demonstrate the HVAC system operates properly through the complete sequence of operation, for example seasonal, occupied/unoccupied, warm-up. Demonstrate proper control system response for abnormal conditions for which there is a specified response by simulating these conditions. Demonstrate hardware interlocks and safeties work. Demonstrate the control system performs the correct sequence of control after a loss of power.

f. Furnish the Government graphed trends of control loops to demonstrate the control loop is stable and that setpoint is maintained. Control loop response shall respond to setpoint changes and stabilize in 1 minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one minute.

### 3.3.3 Test Reporting for Performance Verification Tests

a. Document all tests with detailed test results. Explain in detail the nature of each failure and corrective action taken.

b. After the Performance Verification Tests, identify, determine causes, replace, repair or calibrate equipment that fails to meet the specification, and deliver a written report to the Government.

c. Provide a written report containing test documentation after the Performance Verification Tests. Convene a test review meeting at the job site to present the results to the Government. As part of this test review meeting, demonstrate by performing all portions of the performance verification test that each failure has been corrected. Based on the report and test review meeting, the Government will determine either the restart point or successful completion of testing. Do not commence retesting until after receipt of written notification by the Government. At the conclusion of retesting, assessment will be repeated.

-- End of Section --