

Specifications

Repair and Preservation of Matthew Jones House

Project #: HERT 20-2645

Fort Eustis, VA

100% Design Submission

May 15, 2025





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SECTION 02 42 91

REMOVAL AND SALVAGE OF HISTORIC CONSTRUCTION MATERIALS 11/18

PART 1 GENERAL

1.1 REFERENCES

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

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

29	CFR	1910.1000	Air Cor	ntaminant	S			
29	CFR	1926.55	Gases,	Vapors,	Fumes,	Dusts,	and	Mists
40	CFR	261	Identif Waste	fication	and Li	sting o	f Ha	zardous

1.2 PROJECT DESCRIPTION

The work includes removal and salvage of identified historic items and materials, and removal of resulting rubbish and debris. General demolition of non-historic materials and removal of resulting rubbish and debris must comply with the requirements of Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION]. Store salvaged or recycled materials daily in areas and in a manner specified by the Contracting Officer. In the interest of conservation, pursue salvage and recycling to the maximum extent possible. Submit a Work Plan that includes procedures proposed for the accomplishment of the work. The Work Planprocedures must provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged or recycled, dust control, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations in the Work Plan.

1.2.1 Dust Control

Control the amount of dust resulting from removal, salvage and demolition operations to prevent the spread of dust to occupied portions of the construction site, to avoid creation of a nuisance in the surrounding area and to minimize occupational exposures. Occupational exposures cannot exceed the requirements in 29 CFR 1910.1000 and 29 CFR 1926.55. Use of water to control dust will not be permitted when it will result in, or create, damage to existing building materials and hazardous or objectionable conditions such as ice, flooding and pollution.

1.2.2 Protection

1.2.2.1 Protection of Existing Historic Property

Survey the site and examine the drawings and specifications to determine the extent of work before beginning any removal, salvage or demolition work. Take necessary precautions to avoid damage to existing historic

items that are to remain in place, to be reused, or to remain the property of the Government. Repair or restore items damaged by the Contractor to original condition, or replace, as approved by the Contracting Officer. Coordinate the work of this section with all other work and construct and maintain shoring, bracing and supports, as required. Ensure that structural elements are not overloaded and provide additional supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.2.2.2 Protection From the Weather

Protect the interior of buildings to remain and salvageable materials from the weather at all times. Store salvaged historic materials off the ground and under weathertight covering.

1.2.2.3 Environmental Protection

Comply with the requirements of Section 02 82 00 ASBESTOS REMEDIATION and [Section 02 83 00 LEAD REMEDIATION]. Ensure a thorough inspection has been performed for hazardous materials prior to beginning work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G

1.4 QUALIFICATIONS

Provide qualified workers trained and experienced in whole-building recycling, including removal and salvage of historic materials. Submit documentation of five consecutive years of work of this type with a list of similar projects identifying when, where, and for whom the work was done. Provide a current point-of-contact for identified references.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 HAZARDOUS MATERIALS

Unforeseen hazardous materials may exist in wall cavities, beneath floors, in chases, inside various components, as well as other building materials. Exercise extreme care when performing demolition and salvage operations to ensure unexpected hazardous materials area not inadvertently disturbed creating a potential exposure concern. If suspect hazardous materials are observed or encountered, stop work and notify the Contracting Officer immediately.

3.2 SALVAGED ITEMS

Salvage items to the maximum extent possible where indicated. Remove historic items to be salvaged from the structure prior to demolition work. Remove salvageable items by hand labor to the maximum extent possible. Do not damage historic portions of the structure to remain or items identified for salvage. Remove furnishings, equipment, and materials not scheduled for salvage or recycling prior to any salvaging procedures. Keep a complete recording of all salvaged materials including the condition of such materials before, and after, salvage operations.

3.2.1 Masonry

Remove intact and salvage the following masonry items: brick, stone, cast stone, cornerstones [].

3.2.2 Metals

Remove intact and salvage the following metal items: architectural metalwork , ornamental ironwork

3.2.3 Wood

Remove intact and salvage the following materials: wood decking, millwork, custom paneling, wood stairs and handrails, architectural woodwork, custom casework, wood timbers

3.2.4 Doors and Windows

Remove doors and windows with associated hardware and operating mechanisms intact (including glass) and salvagein accordance with the schedule.

3.2.5 Finishes

[Remove][protect] the following special or historic finishes : molded ornament, wood flooring

3.2.6 Equipment and Specialty Items

Remove intact and salvage the following equipment and specialty items: louvers and vents, document boxes

3.3 RECYCLED MATERIALS

Recycle materials to the maximum extent possible. Use hand labor wherever possible to remove recyclable materials. Do not damage historic portions of the structure indicated to remain and items identified for salvage while removing materials for recycling. Recycle the following materials: dimension lumber

3.4 DISPOSITION OF MATERIALS

The Contractor, upon receipt of notice to proceed, is vested with the title to materials and equipment to be demolished, except Government and using service salvage and historical items. The Government will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.4.1 Material Salvaged for the Contractor

Temporarily store salvaged material as approved by the Contracting Officer and remove from Government property before completion of the contract. Sale of salvaged material on the site is prohibited.

3.4.2 Items Salvaged for the Government

Remove salvaged items to remain the property of the Government in a manner to prevent damage, packed or crated to protect the items from damage, or as directed by the Contracting Officer. Repair or replace items damaged during removal or storage to match existing items. Properly label and identify containers as to contents. Deliver the following items reserved as property of the Government to the areas designated: [].

3.4.3 Items Salvaged for the Using Service

Prior to commencement of work under this contract, remove the following items reserved as property of the using service: [].

3.5 CLEAN-UP

Upon completion of the work, clean portions of structure to remain and adjacent areas and structures of dust, dirt, and debris caused by salvage and demolition operations. Verify that debris and rubbish created by the work is non-hazardous. If any debris and rubbish is suspect hazardous waste characterize it in accordance with 40 CFR 261. If the debris and rubbish is determined to be hazardous materials notify the Contracting Officer. Remove and transport non-hazardous debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Transport and dispose of all material in accordance with all local, state and Federal regulations. Provide copies of all disposal manifests to the the Contracting Officer.

-- End of Section --

SECTION 03 01 30

RESTORATION OF CONCRETE IN HISTORIC STRUCTURES 11/09

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Measurement of Concrete

The quantity of concrete to be paid for will be the number of cubic feet placed in the completed and accepted renovated areas.

1.1.2 Payment for Concrete

The quantity of concrete, measured as specified, will be paid for at the contract unit price. The unit price for concrete will include full compensation for furnishing labor; materials; tools and equipment; and for performing work involved in repair of the areas as specified.

1.2 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005;	R 2017	7) Sta	andarc	l Spec	cif:	icatior	n for
	Burlap	Cloth	Made	from	Jute	or	Kenaf	and
	Cotton	Mats						

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 224.1R	(2007) Causes, Evaluation, and Repair of Cracks in Concrete Structures
ACI 301	(2016) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 318	(2014; Errata 1-2 2014; Errata 3-5 2015; Errata 6 2016; Errata 7 2017) Building Code Requirements for Structural Concrete and Commentary

ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete
ACI 364.1R	(2007) Guide for Evaluation of Concrete Structures Before Rehabilitation
ACI 437R	(2003) Strength Evaluation of Existing Concrete Buildings
ACI SP-66	(2004) ACI Detailing Manual
ASTM INTERNATIONAL (AST	M)
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C109/C109M	(2016a) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1218/C1218M	(1999; R 2008) Standard Specification for Water-Soluble Chloride in Mortar and Concrete
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C171	(2016) Standard Specification for Sheet Materials for Curing Concrete
ASTM C192/C192M	(2016a) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2017) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C295/C295M (2012) Petrographic Examination of Aggregates for Concrete

ASTM	C31/C31M	(2015a; E 2016) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM	C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM	С39/С39М	(2017) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM	C42/C42M	(2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM	C457/C457M	(2016) Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
ASTM	C494/C494M	(2016) Standard Specification for Chemical Admixtures for Concrete
ASTM	C597	(2016) Pulse Velocity Through Concrete
ASTM	C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM	C642	(2013) Density, Absorption, and Voids in Hardened Concrete
ASTM	C78/C78M	(2016) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM	C803/C803M	(2003; R 2010) Penetration Resistance of Hardened Concrete
ASTM	C805/C805M	(2013a) Rebound Number of Hardened Concrete
ASTM	C823/C823M	(2012) Examination and Sampling of Hardened Concrete in Construction
ASTM	C856	(2017) Standard Practice for Petrographic Examination of Hardened Concrete
ASTM	C881/C881M	(2015) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM	С979/С979М	(2016) Standard Specification for Pigments for Integrally Colored Concrete
ASTM	С989/С989М	(2017) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM	D75/D75M	(2014) Standard Practice for Sampling Aggregates

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300

(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

1.3 SYSTEM DESCRIPTION

The Contractor is responsible for equipment, materials, testing, labor and other items and services required to accomplish the work. Equipment and techniques proposed for use in the work shall not be used until they have been demonstrated and approved. Materials and equipment, which have not been approved for use in the work, shall not be stored or brought on to Government property. Provide equipment, materials, and labor to demonstrate materials, equipment, and techniques proposed for use in the work. Perform the demonstrations at the site, at a time and location as directed. The demonstration shall include surface cleaning, excavation, surface patching (including finishing, texturing, and curing materials and methods), curing, safety procedures, surface finish and appearance. The Contractor's quality control shall conform to Section 01 45 00.00 10 QUALITY CONTROL. All sampling and testing shall be the Contractor's responsibility, and shall be performed by an approved independent commercial testing laboratory, except as otherwise specified.

1.3.1 Compressive Strength

Each class or mixture of concrete and mortar proposed for use in the work shall have a 28-day compressive strength matching the compressive strength of the adjacent existing concrete in the structure as determined by ASTM C39/C39M for concrete and ASTM C109/C109M for mortar. Determine the compressive strength of the existing concrete from testing of samples for each portion of the work in accordance with ASTM C42/C42M. Take test specimens of existing concrete from a sound and intact representative portion of the structure, at locations indicated.

1.3.2 Air Entrainment

Each class or mixture of concrete and mortar proposed for use in the work shall have a total air content matching the total air content of the adjacent concrete. Determine air content of the proposed mixture in accordance with ASTM C231/C231M. When air-entrained concrete is required for resistance to freezing and thawing, the concrete shall contain an air-entraining admixture conforming to ASTM C260/C260M and having an air content as indicated in ACI 301, (Table 3.4.1).

1.3.3 Admixtures

Concrete may contain admixtures, such as pigments, water reducers, high-range water reducers, or set retarders to provide special properties to the concrete. Use of admixtures shall be subject to approval.

1.3.4 Cementitious Content

Each class or mixture of concrete and mortar proposed for use in the work shall have a cement content matching the cement content of the adjacent existing concrete in order to provide uniform strength, weathering characteristics, and appearance of repaired surfaces in relation to existing surfaces.

1.3.5 Slump

Determine slump in accordance with ASTM C143/C143M, and within the following limits:

Structural Element	Slump *					
	Minimum	Maximum				
Walls, columns, and beams	2 inches	4 inches				
Foundation walls, substructure walls, footings, pavement, and slabs	1 inch	3 inches				
Any structural concrete approved for placement by pumping	None	6 inches				
*These slump requirements do not apply when admixtures conforming to ASTM C1017/C1017M are approved to produce flowing concrete.						

1.3.6 Proportions of Mixtures

- a. Provide trial batches that contain materials proposed to be used in the project. Make trial mixtures having proportions, consistencies and air content suitable for the work based on methodology described in ACI 211.1, using at least three different water/cement (w/c) ratios. In the case where ground granulated iron blast-furnace slag conforming to ASTM C989/C989M is used, the mass of the slag will be substituted in the equations for the term P which is used to denote the mass of pozzolan. Design trial mixtures for maximum permitted slump and air content.
- b. The concrete and mortar patching mixtures shall be designed using the lowest practical w/c ratio. Report the temperature, slump, and air content of the concrete and mortar mixtures in each trial batch. For each w/c ratio, at least three test specimens for each test age shall be made and cured in accordance with ASTM C192/C192M and ASTM C109/C109M. They shall be tested at 7 and 28 days in accordance with ASTM C39/C39M for concrete and ASTM C109/C109M for mortar. From these test results plot a curve showing the relationship between w/c ratio and strength. For each strength of concrete the maximum allowable w/c ratio shall be that shown by these curves to produce an average strength as specified in paragraph Average Strength. Materials, physical and chemical properties, and composition of concrete and mortar patch mixtures shall match the existing concrete to be repaired, except that patching mixtures shall have the lowest total chlorides content practical and shall conform to ACI recommendation for maximum permitted total chloride content.
- c. Submit the results of trial mixture along with a statement giving the maximum nominal coarse aggregate size, aggregate grading, and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate quantities (by mass) shall be based on the saturated surface-dry condition. Include in the statement a complete petrographic analysis of the aggregates proposed for use in the concrete. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work

without additional tests to show that the quality of the concrete is satisfactory.

1.3.6.1 Average Strength

In meeting the strength requirements specified, the selected mixture shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, establish a standard deviation. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 500 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

1.3.6.2 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 500 psi.

1.3.6.3 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following Table:

No. of tests (1)	Modification factors for standard deviation	
less than 15	See Note	
15	1.16	
20	1.08	
25	1.03	
30 or more	1.00	
(1) Interpolate for intermediate numbers of tests		

(1) Interpolate for intermediate numbers of tests.

Note: When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be specified strength plus 500 psi.

1.3.7 Sampling and Laboratory Testing of Materials

Sampling and testing shall be performed by an approved independent commercial testing laboratory, or by the Contractor subject to approval. Should the Contractor elect to establish testing facilities, no work

requiring testing shall be permitted until the Contractor's facilities have been inspected and approved. All sampling and testing shall be the Contractor's responsibility. Submit certified copies of laboratory test reports on analysis of existing concrete composition and new concrete mixtures, including all test data, for aggregate, admixtures, and curing compound. Perform these tests using an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

1.3.7.1 Existing Concrete Testing

Take representative samples of existing concrete from areas of the structure to be repaired at indicated locations in accordance with ASTM C42/C42M and ASTM C823/C823M and tested in accordance with ASTM C39/C39M, ASTM C42/C42M, ASTM C295/C295M, ASTM C457/C457M, ASTM C856, ASTM C1218/C1218M. Evaluate aggregates in the existing concrete in accordance with ASTM C136/C136M and ASTM C295/C295M. The air content of the existing concrete shall be determined in accordance with ASTM C457/C457M and ASTM C457/C457M

1.3.7.2 Acceptance of Cement

Test cement for repair concrete and mortars as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification. The mill test reports and certification of compliance shall clearly reference the applicable ASTM documents and present the test result data. Cement shall conform to the specified requirements, and where the cement consists of a blend of cement and pozzolan, the pozzolan shall conform to the specified requirements for pozzolan, and the blend of cement and pozzolan shall conform to ASTM C1107/C1107M and all other specified requirements.

1.3.7.3 Aggregate

Take aggregate samples for repair concrete and mortars for laboratory testing in conformance with ASTM D75/D75M and test them in accordance with ASTM C33/C33M, ASTM C136/C136M, and ASTM C295/C295M.

1.3.7.4 Epoxy-Resin Grout

Test epoxy-resin grout for conformance with ASTM C881/C881M.

1.3.8 Concrete Mixture

The concrete mixture shall match that of the existing concrete to be repaired unless otherwise directed and shall be designed in accordance with ACI 211.1. The mixture proportions shall include consideration of the finishes required.

1.3.9 Formwork Design

Formwork design shall conform to ACI 301 and ACI 347.

1.3.10 Technical Service for Specialized Concrete

Obtain the service of a technical representative to oversee proportioning, batching, mixing, placing, consolidating, and finishing of concrete and mortar, until field controls indicate specialized concrete of specified quality is furnished.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Proportions of Mixtures; G Qualifications

SD-04 Samples

Materials; G

SD-06 Test Reports

Sampling and Laboratory Testing of Materials

SD-07 Certificates

Materials

1.5 QUALITY ASSURANCE

Provide qualifications of workers trained and experienced in restoration of concrete in historic structures for at least 5 consecutive years. Provide a list of similar jobs identifying when, where, and for whom the work was done. Submit a certified statement attesting that the experience and qualification of the workers (journeymen) comply with the specifications.

1.5.1 Sample Panels

Submit for approval sample panels of each mixture proposed for use in the work. No concrete of mortar shall be used in the work until the samples and the represented mixture has been approved. Materials proposed for use in producing concrete and mortar shall not be brought on to Government property until the samples and mixtures have been approved. Evaluate samples for each side of the structure, both close up and at a distance, under both wet and dry conditions. Each patch location and each side of the structure may require a separate or different mixture.

1.5.2 Detail Drawings

Submit detail drawings conforming to ACI SP-66 and ACI 318 and showing location of architectural concrete elements in the work, building elevations, formwork fabrication details, reinforcements, embedments, dimensions, concrete strength, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, stripping, and finishing.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver cement in suitable bags used for packaging cements. Labeling of packages shall clearly define contents, manufacturer, batch identification, etc. Store cement and pozzolan in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Arrange aggregate stockpiles and use them in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than six months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Store epoxy in accordance with the manufacturer's recommendations.

1.7 ENVIRONMENTAL REQUIREMENTS

Concrete, mortar, and epoxy adhesives shall not be placed when weather conditions detrimentally affect the quality of the finished product. No concrete or mortar shall be placed when the air temperature is below 40 degrees F in the shade. When air temperature is likely to exceed 90 degrees F, concrete and mortar shall have a temperature not exceeding 90 degrees F when deposited, and the surface of the placed concrete shall be kept damp with a water fog until the approved curing medium is applied. Materials proposed for use in the work shall not be produced and placed during periods of rain or other precipitation. Stop material placements and protect all in-place material from exposure during periods of rain or other precipitation.

PART 2 PRODUCTS

2.1 MATERIALS

Materials, physical and chemical properties, and composition of new concrete shall match that of existing concrete to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or non-performing. Submit a minimum of 3 sample specimens for each proposed mixture at least 14 days prior to any placements, in order to demonstrate range of variation of each mixture. Submit samples of cured concrete and mortar patching specimens for each mixture for comparison with the cleaned structure. Samples of concrete and mortar shall be approximately 12 by 12 inches in plan dimension and 1 to 1-1/2 inches thick. The samples shall clearly indicate the mixture represented by the specimen, and shall have been produced, placed, finished, textured, and cured in the same manner as proposed for use in the work. Check the samples for matches in color and shade, finish, texture, and surface defects. Compare the samples to that part of the structure on which the mixture is proposed to be used. The samples shall be compared to the thoroughly cleaned structure. The samples and structure surfaces shall be clean and completely dry during the comparison. Following the comparison to dry surfaces, dampen the sample and structure with clean, potable water and compare the surfaces for acceptability to the Contracting Officer. Submit certificates of compliance attesting that the materials meet specification requirements.

2.1.1 Admixtures

Air entraining admixtures shall conform to ASTM C260/C260M, water-reducing or -retarding admixtures shall conform to ASTM C494/C494M, and pigments for

integrally colored concrete shall conform to ASTM C979/C979M and ASTM C1017/C1017M. Admixtures shall not contain added chlorides.

2.1.2 Aggregates

Aggregates shall match existing aggregates as determined by samples and testing and shall otherwise conform to ASTM C33/C33M.

2.1.3 Bonding Agents

Bonding agents for use in bonding concrete and mortar patching materials to concrete and steel are specifically prohibited for use in the work.

2.1.4 Cementitious Materials

Provide cementitious materials of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.1.4.1 Cement

Cement composition shall match that of cement used in existing concrete to be repaired as determined by samples and testing and shall conform to the basic requirements of ASTM C150/C150M, Type I. Cement shall have non-shrink (shrinkage compensating) properties and shall conform to ASTM C1107/C1107M, Class B or C, expansive cement type.

2.1.4.2 Pozzolan

Pozzolan shall conform to ASTM C618, Class C or F, including low alkali multiple factor, drying shrinkage, uniformity, and moderate sulfate resistance requirements of "Table 2A - Supplementary Optional Physical Requirements." Requirements for maximum alkalis shall apply when used with aggregates listed to require low-alkali cement.

2.1.5 Epoxy Anchor Adhesives

Use an epoxy-resin grout to bond steel anchors to concrete, with a 100 percent solids, moisture insensitive, low creep, structural adhesive. The epoxy shall conform to ASTM C881/C881M, type IV; grade and class selected to conform to the manufacturer's recommendations for the application. The epoxy adhesive shall be conditioned, proportioned, mixed, and applied in accordance with the manufacturer's recommendations, except as otherwise specified herein or indicated on the drawings.

2.1.6 Reinforcing Steel

Reinforcing steel shall conform to ASTM A36/A36M, sizes as indicated, unless otherwise directed.

2.1.7 Tie Wire

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

2.1.8 Metal attachments

Anchors for spall repairs shall be threaded stainless steel, size as indicated. Other plates, angles, anchors, and embedments shall conform to ASTM A36/A36M, and shall be prime painted with inorganic zinc primer.

2.1.9 Formwork

Formwork for special effects shall be as indicated or directed, and shall be subject to specific approval.

2.1.10 Form-Release Agents

Form-release agents shall be the manufacturer's standard, nonstaining, nonpetroleum based, compatible with surface finish and subsequent surface treatments.

2.1.11 Cleaning Solution

The cleaning solution shall consist of a 1:1 to 1:1.5 (water: liquid chlorine bleach) mixture of clean potable water and liquid chlorine bleach. Rinse water shall be clean potable water.

2.1.12 Water

Water used in cleaning concrete surfaces, used in producing concrete and mortars, and used for curing concrete shall be potable.

- 2.1.13 Curing Materials
- 2.1.13.1 Burlap

AASHTO M 182.

2.1.13.2 Impervious Sheets

ASTM C171, type optional, except that polyethylene film, if used, shall be white opaque.

2.1.13.3 Membrane-Forming Compounds

COE CRD-C 300, non-pigmented, containing a fugitive dye.

2.1.14 Joint Sealing

Provide joint sealing as specified in Section 07 92 00 JOINT SEALANTS.

2.1.15 Epoxy-Resin Grout

Epoxy-resin grout shall be a two-component material, 100 percent solids by weight, formulated to meet the requirements of ASTM C881/C881M, Type I or II. Type I material shall be used when materials or atmospheric temperatures are 70 degrees F or above. Use Type II material when materials or atmospheric temperatures are below 70 degrees F. Epoxy-resin grout shall have the ability to structurally rebond cracks, delaminations, and hollow plane conditions in concrete; shall be insensitive to the presence of water; and shall have the capability to penetrate cracks down to 5 mils in width. Materials shall have been used in similar conditions for

a period of at least five years.

2.1.16 Epoxy Injection Ports

Design injection ports for epoxy-resin grout for the intended use as detailed in this section, made according to the recommendation of the epoxy

manufacturer.

2.2 EQUIPMENT

Assemble equipment, that is dependable and adequate to accomplish the specified work, at the work site in sufficient time before the start of the work to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required. Maintain the equipment in acceptable working condition during the life of the project.

2.2.1 Cleaning

Equipment used in cleaning shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

2.2.1.1 Sandblasting

Sandblasting equipment shall not be used in cleaning concrete and other building surfaces; and shall be subject to approval for each other specific applications. Sandblasting equipment permitted for use in cleaning reinforcement and other embedded metal items shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening shall not exceed 1/4 inch. Provide a portable air compressor capable of furnishing not less than 150 cubic feet per minute and maintaining a line pressure of not less than 90 psi at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the reinforcement and other items to be cleaned, and will maintain the nozzle approximately 1 inch above the surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to provide satisfactory results. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.2.1.2 Water Blasting

Water blasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The equipment shall not be operated at a pressure which will cause etching or other damage to the concrete surface, except for the surfaces of the interior of the excavation, where operation at higher pressures may be used, subject to specific approval. Operate the equipment at a discharge capacity of 55 psi maximum and 2.5 to 3 gpm for general surface cleaning operations of the structure, and between 500 and 1000 psi and 2.5 to 3 gpm for cleaning of drill holes and surfaces of excavations. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.2.2 Excavation

The equipment used to excavate concrete shall be handheld manual or power type with a low-impact energy output and shall have gad points. The use of chisel points is prohibited. Surface grinders for use in preparing concrete and metal surfaces shall be small, hand-held equipment with a slow to moderate operating RPM, using stone grinding wheels. Saw cutting equipment shall use circular diamond blades. The blade shall be at least

1/8 inch thick, with blade diameter selected as appropriate for the application. Excavation equipment shall be subject to approval.

2.2.3 Drilling

Equipment used to drill holes in concrete for patch anchors and other applications shall be standard handheld masonry drills, commonly used for drilling small holes in concrete and masonry. The drill shall be a small, powered, handheld type, using rotary drilling mode only. Impact and rotary impact type drills are prohibited.

2.2.4 Finishing and Texturing

Provide hand tools used for placing, finishing and texturing concrete and mortar which are commercially available and commonly used in concrete construction and repair. Equipment used for finishing and texturing concrete and mortar surfaces shall be a type commonly used in the concrete construction and repair industry for that application. Surface grinders, impact tools, and other equipment shall conform to the requirements specified herein, except as specifically required by the type of finish and texture, and subject to approval.

2.2.5 Compressed Air Supplies

Compressed air shall provide clean, oil and moisture free compressed air at the surface to be cleaned. The compressed air line shall have at least two in-line air filters to remove oil and moisture from the air supply. The compressed air supply shall be tested during each shift for the presence of oil and moisture.

2.2.6 Mixing, Transporting, and Placing

Equipment used for mixing, transporting, placing, and confining concrete and mortar placements shall be suitable for the intended purpose and be capable of satisfactorily mixing material, and supporting placement operations in an uninterrupted manner. Maintain equipment in a clean, good operable condition at all times. Equipment used in the work shall be subject to approval. Defects, and deficiencies in operation or capacity shall be resolved prior to use in the work. Equipment used for batching, mixing, conveying, and placing of materials shall be clean, free of old materials and contaminants, and shall conform to the manufacturer's recommendations.

2.2.7 Associated Equipment

Provide associated equipment such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools as required to ensure a continuous supply of material and operation control. Use mechanical or radio communication systems between elements of mortar production and placement operation which are more than 100 feet apart.

PART 3 EXECUTION

3.1 EVALUATION AND ANALYSIS

Use evaluation and analysis conforming to the requirements specified herein.

3.1.1 Existing Concrete

Concrete renovation shall be undertaken only after a complete evaluation and analysis of the areas to be repaired is completed, including sampling and testing of the existing concrete to determine its composition and qualities. A condition survey of the area to be repaired shall conform to ACI 201.1R and ACI 364.1R. Strength evaluation shall be in accordance with ACI 437R. Cracks shall be evaluated in accordance with ACI 224.1R. Examination and sampling procedures shall conform to ASTM C823/C823M.

3.1.2 Evaluation and Acceptance of New Concrete

3.1.2.1 Frequency of Testing

Take samples for strength, slump, air content, and shrinkage tests of each concrete mixture placed each day not less than once a day, and at least once for each 10 cubic feet of concrete; nor less than once for each 500 square feet of surface area for slabs or walls. Take samples for strength, slump, air content, and shrinkage tests of each mortar mixture placed each day not less than once a day, and at least for each 9 cubic feet of mortar. If this sampling frequency results in less than 3 strength tests for a given class of concrete or individual mixture design, tests shall be made from at least 3 randomly selected trucks (or batches) or from each truck (or batch) if fewer than 3 truck loads (or batches) are used. Field cured specimens for determining form-removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.1.2.2 Testing Procedures

Strength test specimens for acceptance tests shall be molded and cured in accordance with ASTM C31/C31M. Strength test specimens and testing for mortar shall conform to ASTM C109/C109M. Cylinders shall be tested in accordance with ASTM C39/C39M and beams shall be tested in accordance with ASTM C78/C78M. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at another specified test age. Tests for total air content and slump shall be made on fresh samples of the concrete and mortar. Perform tests onsite, on samples taken at the location of placement. Determine slump in accordance with ASTM C143/C143M. Determine air content in accordance with ASTM C231/C231M. Determine testing for shrinkage in accordance with ASTM C1107/C1107M.

3.1.2.3 Evaluation of Results

Concrete and mortar shall have a compressive strength at 28 days as determined by ASTM C39/C39M and ASTM C109/C109M respectively, which matches the present compressive strength of concrete in the structure within a tolerance of from -0 to +500 psi. Concrete and mortar strengths will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength. For flexural strength concrete, the strength level of the concrete will be considered satisfactory if the averages of all sets of five consecutive strength test results equal or exceed the required flexural strength, and not more than 20 percent of the strength test results fall below the

required strength by more than 50 psi. The required minimum strength shall be the strength determined from testing of samples taken from the structure.

3.1.2.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test specimen falls below the specified strength requirement by more than 500 psi, or if tests of field-cured specimens indicate deficiencies in protection and curing, steps shall be taken to ensure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C597, ASTM C803/C803M, or ASTM C805/C805M may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, obtain cores and test them in accordance with ASTM C42/C42M. Take at least three representative cores from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure is dry under service conditions, the cores shall be air-dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure is more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C42/C42M. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

3.2 PREPARATION OF CONCRETE SURFACES

3.2.1 Initial Surface Cleaning

Following an initial inspection and evaluation of the structure and surfaces, give the structure an initial surface cleaning to be completed prior to start of excavation, and sampling and testing for mixtures. The initial cleaning shall provide for the complete cleaning of all exterior concrete surfaces of the structures. The initial cleaning shall thoroughly clean the concrete surface to remove all traces of moss, dirt, and other contaminants. The cleaning shall provide a clean concrete surface to allow determination of the concrete's color and shades, finish and texture, and other properties. The "initial cleaning" shall consist of initial surface washing, followed by treatment with the cleaning solution, and then followed by a final water rinse. The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure.

Water and all liquid materials used in the work shall be collected and contained at the building perimeter and disposed of in an approved manner.

3.2.1.1 Demonstrate Methods

Demonstrate the materials, equipment, and methods proposed for use in cleaning in a 3 by 3 foot square test section. The location of the test section, and the completed test section shall be subject to approval. Adjust the cleaning process as required and rerun the test section until an acceptable process is obtained.

3.2.1.2 Wash Surface

The initial surface washing shall consist of washing the surface with clean, low pressure water (pressure of less than 55 psi and 2.5 to 3 gpm discharge) and manual surface scrubbing using handheld natural or plastic bristle brushes, followed by a clean water rinse.

Following completion of the initial surface washing of the entire structure (or side of structure) dry the concrete prior to application of the cleaning solution.

3.2.1.3 Apply Cleaning Solution

The concrete surfaces of the structure shall be coated with the cleaning solution at an application rate of 1 gal of solution per 10 to 30 square feet of treated surface using low pressure spraying equipment. Adjust the application rate of the solution as directed to ensure that the entire surface has been thoroughly wetted with the solution.

Use a manual surface scrubbing with handheld natural or plastic bristle brushes on heavily soiled areas. Following treatment with the cleaning solution, rinse the treated surfaces with clean, low-pressure water.

3.2.2 Areas to be Removed

Remove unsound, weak, or damaged concrete. Loose particles, laitance, spalling, cracked, or debonded concrete and foreign materials shall be removed with hand tools unless otherwise noted. Protect surfaces of the structure, and surfaces adjacent to the excavation from damage which may result from excavation, cleaning, and patching operations.

3.2.3 Exposed Reinforcement

Remove concrete from around exposed or deteriorated reinforcing steel. Steel shall stand free of concrete at least 1 inch minimum to provide mechanical bond with patch material.

3.2.4 Excavation in Concrete

Excavate deteriorated areas indicated to be repaired to sound concrete. The use of concrete and masonry saws for outlining the excavation shall not be allowed. Accomplish the excavation by means of manual methods and low-energy, handheld equipment. The sides of the excavation shall be approximately perpendicular to the exposed surface, dovetailed back 15 degrees from perpendicular to the exposed surface at the bottom in order to key in the patch. The bottom (or back) of the excavation shall be approximately parallel with the exposed surface of the patch. The surfaces of the excavation shall be finished to remove excessive variations and roughness and shall be shaped to provide a patch with uniform dimensions. Feathering at edges is not permitted. The excavation shall be accomplished

to minimize the appearance of bond lines between the patch and the adjacent concrete and other abutting surfaces. Protect surfaces of the structure and surfaces adjacent to the excavation from damage which may result from excavation operations.

3.2.5 Cleaning of Excavations

Clean the surfaces of the excavation by water blasting and manual scrubbing methods. Sandblasting shall not be used to clean concrete surfaces. The surfaces of excavations shall be cleaned of dust, dirt, laitance, corrosion, or other contamination. Cracks and voids shall be flushed out with clean water and allowed to dry. Concrete surfaces to be in contact with the freshly placed concrete shall be maintained in a continuously damp condition for at least 24 hours prior to concrete placement. Immediately before placement, areas to be patched shall be cleaned and rinsed, followed by blowing dry with filtered, dry, compressed air to remove excess water, and to provide a surface in a saturated, surface-dry, damp condition. Protect surfaces of the structure and surfaces adjacent to the excavation from damage which may result from cleaning operations.

3.2.6 Previously Repaired Cracks

Remove old caulking or grout from previously repaired cracks where it is failing. Remove loose particles from cracks. Cracks shall be cleaned, rinsed with water followed by blowing with filtered, dry, compressed air.

3.3 REINFORCING STEEL

3.3.1 Cleaning

Exposed reinforcing steel shall be mechanically cleaned to bare metal. Paint exposed steel in areas to be patched with two coats of zinc-rich primer paint.

3.3.2 Repairing

Notify the Contracting Officer of any steel members which have significant loss in cross-sectional area due to corrosion, cutting, or other damage. Damaged portions shall be mechanically cut away. Install reinforcing steel to match existing, where existing reinforcing is badly corroded or damaged. Lap splices shall be as required by code. If necessary, fasten bars with tie wires.

3.4 FORMWORK ERECTION

Erect formwork in accordance with the detail drawings to ensure that the finished concrete members conform accurately to the indicated dimensions, lines, elevations, and finishes. Deflection shall not exceed 1/360th of each component span or distance between adjacent supports. Deflections and tolerance shall not be cumulative. Install form liners as necessary to provide the required finish. Forms shall be coated with form release agents before reinforcement is placed.

3.5 CONCRETE REPAIR

3.5.1 General Requisites

Accomplish repairs in accordance with ACI 301, and ACI 304R. Repair cracks, if required, in accordance with ACI 224.1R. Detailing shall be in

accordance with ACI SP-66. Repaired surfaces shall match adjacent existing surfaces in all respects. Provide formwork, as necessary to reconstruct concrete to match adjacent surfaces. Voids shall be filled flush with adjacent surfaces. Use all products in accordance with the manufacturer's instructions.

3.5.2 Spalls

Spalls less than 1 inch deep, where indicated to be repaired, shall be drypacked with an approved patching mortar. Spalls greater than 1 inch deep shall be excavated and patched with concrete or an approved patching mortar suitable for deep repairs. Where required by the drawings, concrete shall be used to allow for matching the existing adjacent concrete finishes (exposed aggregate concrete).

3.5.3 Patch Anchors

Surface areas to be patched, which do not have reinforcement or other metal embedments to be placed in the patching concrete and mortar, shall be provided with patch anchors to ensure that the patch is tied to the existing concrete structure. Provide patch anchors within the excavation at a frequency of at least one patch anchor per 25 square inches of patch plan surface area; specific locations for patch anchors shall be as indicated. Use small handheld, low-speed rotary masonry drills to produce holes in the existing concrete, within the limits of the excavations for the patch anchor installation.

3.5.3.1 Holes

Drill holes into the existing concrete substrate material of the excavation using rotary (non-hammer) drills. Holes shall have a diameter 1/8 inch larger than the anchor diameter. The holes shall be drilled to a depth of 4 inch, except as otherwise indicated or directed. Drill holes shall be produced to ensure that the holes do not penetrate completely through the concrete, and will provide at least 1 inch of cover around the drill hole. Holes shall be cleaned by water blasting to remove drill dust and other debris and then blown dry with filtered, dry, compressed air. Drill holes shall be conditioned in accordance with the epoxy adhesive manufacturer's recommendations.

3.5.3.2 Anchor Installation

Clean anchors to remove all contaminants which may hinder epoxy bond. Epoxy adhesive shall be pressure injected into the back of the drilled holes. The epoxy shall fill the holes so that when the anchors are inserted, the epoxy completely fills the holes and excess epoxy is not exuded from the holes. Insert anchors immediately into the holes. The anchors shall be set back from the exterior face at least 1 inch. Install anchors without breaking or chipping the exposed concrete surface.

3.5.3.3 Cleanup

Remove excess epoxy and spills from the surface of the excavation, leaving it in a clean and uncontaminated condition. Spills on adjacent surfaces shall also be removed and surfaces repaired as required.

3.5.4 Mixing Epoxy-Resin Grout Components

Mix epoxy-resin grout components in the proportions recommended by the

manufacturer. The components shall be conditioned from 70 to 85 degrees F for 48 hours prior to mixing. Mix the two epoxy components with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. The polysulfide curing agent component shall be added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. The rate of stirring shall be such that the entrained air is at a minimum.

3.5.4.1 Tools and Equipment

Tools and equipment used further in the work shall be thoroughly cleaned before the epoxy-resin grout sets.

3.5.4.2 Health and Safety Precautions

Provide full-face shields for all mixing, blending, and placing operations as required and protective coveralls and neoprene-coated gloves for all workers engaged in the operations. Supply protective creams of a suitable nature for the operation. Maintain adequate fire protection at all mixing and placing operations. Smoking or the use of spark- or flame-producing devices shall be prohibited within 50 feet of mixing and placing operations. The mixing, placing, or storage of epoxy-resin grout or solvent shall be prohibited within 50 feet of any vehicle, equipment, aircraft, or machinery that could be damaged from fire or could ignite vapors from the material.

3.5.4.3 Epoxy Pressure-Injection of Cracks

Cracks shall be pressure-injected using a two component epoxy system with an in-line mixing and metering capability. System shall be capable of injection pressures up to a maximum of 150 psi to ensure complete penetration of the crack. Apply an adequate surface seal to the crack or joint to prevent the escape of epoxy. Entry points shall be established along the crack. Fill the crack with a 100 percent solid epoxy adhesive. Inject the adhesive into the crack at the first entry point with sufficient pressure to advance the epoxy to the next adjacent port. The original port shall be sealed and injection moved to the port at which the epoxy appears. Continue the process until each joint and crack has been injected for its entire length. Epoxy shall be allowed to cure in accordance with manufacturer's instructions. Sealing materials shall then be removed and surface finished to match adjacent existing surface.

3.5.5 Application of Concrete and Patching Mortar

Place concrete and mortar to rebuild spalled or damaged areas to match the original surface finish, level, texture, and color. Concrete shall be cured as specified herein. The finished appearance of the patch shall match the adjacent existing surface.

3.6 CURING AND PROTECTION

Use an approved method for curing concrete and mortar patching for at least 7 days. Immediately after placement, protect concrete from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Maintain air and forms in contact with concrete and mortar at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Materials and equipment needed for adequate curing and protection shall be available and at the placement site

prior to placing concrete and mortar. No fire or excessive heat shall be permitted near or in direct contact with the concrete and mortar at any time. Accomplish curing by any of the following methods, or combination thereof, as approved:

3.6.1 Moist Curing

Maintain concrete and mortar to be moist-cured continuously wet for the entire curing period. If water or curing materials stain or discolor concrete and mortar surfaces which are to be permanently exposed, the concrete and mortar surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2 inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene coated burlap, or saturated burlap.

3.6.2 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except that a styrene acrylate or chlorinated rubber compound meeting COE CRD-C 300 requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. Select a curing compound that is compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Apply curing compound to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water, and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Apply compound in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage of 200 square feet per gallon. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Keep surfaces coated with curing compound free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.6.3 Epoxy Adhesives

Protect and cure epoxy adhesives in accordance with the manufacturer's recommendations. The adjacent surfaces and ambient conditions shall be maintained within the manufacturer's recommendations. The patch anchors and epoxy adhesive shall be protected from displacement and disturbances.

3.7 CONCRETE AND MORTAR FINISHES AND COLOR

3.7.1 Matching Adjacent Concrete

Concrete and mortar finishes and color shall match the finish and color of the existing adjacent concrete. Accomplish finishing at the time of concrete placement or immediately after formwork removal.

3.7.2 Non-Standard Finish

The exposed surfaces of concrete and mortar patching shall match the finish, texture, and surface detail of the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance. The finishing and texturing shall be accomplished in such a way as to help conceal bond lines between the patch and adjacent surfaces. The texturing shall replicate all surface details, including tooling and machine marks. The equipment used in finishing and texturing shall be a low-impact energy type which will not weaken the patch or damage the patch bond and the adjacent concrete. Equipment used for finishing and texturing shall be demonstrated on sample panels of concrete and mortar to demonstrate performance and suitability of the equipment and methods. Equipment and methods shall be subject to approval.

3.8 FINAL CLEANING

No sooner than 72 hours after completion of the curing period and after joints are sealed, faces and other exposed surfaces of concrete shall be washed down with water applied with a soft bristle brush, then rinsed with clean water. Discolorations which cannot be removed by these procedures, will be considered defective work. Perform cleaning work when temperature and humidity conditions are such that surfaces dry rapidly. Protect adjacent surfaces from damage during cleaning operations.

3.9 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.10 DEFECTIVE WORK

Repair or replace defective work, as directed, using approved procedures.

3.11 FINAL INSPECTION

Following completion of the work, inspect the structure for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects. Inspect the finish, texture, color and shade, and surface tolerances of the patches to verify that all requirements have been met. Repair all surfaces exhibiting defects, as directed.

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE 02/19

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONCRETE INSTITUTE (ACI)

ACI	117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI	121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI	301	(2016) Specifications for Structural Concrete
ACI	302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI	304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI	304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI	305R	(2010) Guide to Hot Weather Concreting
ACI	306R	(2016) Guide to Cold Weather Concreting
ACI	308.1	(2011) Specification for Curing Concrete
ACI	SP-2	(2007; Abstract: 10th Edition) ACI Manual of Concrete Inspection
ACI	SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References
	AMERICAN HARDBOARD AS	SSOCIATION (AHA)
AHA	A135.4	(1995; R 2004) Basic Hardboard
	AMERICAN WELDING SOCI	ETY (AWS)
AWS	D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A184/A184M	(2019) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2016) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A820/A820M	(2016) Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
ASTM A884/A884M	(2019) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934/A934M	(2016) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A970/A970M	(2018) Standard Specification for Headed Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1044/A1044M	(2016a) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2019a) Standard Practice for Making and

		Curing Concrete Test Specimens in the Field
ASTM (C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM (C39/C39M	(2020) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM (C42/C42M	(2018a) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM (C78/C78M	(2018) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM (C94/C94M	(2018) Standard Specification for Ready-Mixed Concrete
ASTM (C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM (C150/C150M	(2018) Standard Specification for Portland Cement
ASTM (C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM (C173/C173M	(2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM (C231/C231M	(2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM (C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM (C311/C311M	(2018) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM (C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM (C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM (2552	(2017; E 2018) Standard Specification for Cellular Glass Thermal Insulation
ASTM (2578	(2018) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM (2591	(2019a) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate

Thermal Insulation ASTM C595/C595M (2018) Standard Specification for Blended Hydraulic Cements (2019) Standard Specification for Coal Fly ASTM C618 Ash and Raw or Calcined Natural Pozzolan for Use in Concrete ASTM C803/C803M (2018) Standard Test Method for Penetration Resistance of Hardened Concrete ASTM C845/C845M (2018) Standard Specification for Expansive Hydraulic Cement ASTM C873/C873M (2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds (2015) Standard Test Method for Pullout ASTM C900 Strength of Hardened Concrete ASTM C920 (2018) Standard Specification for Elastomeric Joint Sealants ASTM C989/C989M (2018a) Standard Specification for Slag Cement for Use in Concrete and Mortars (2018b) Standard Test Method for Length ASTM C1012/C1012M Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution ASTM C1017/C1017M (2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete ASTM C1074 (2011) Standard Practice for Estimating Concrete Strength by the Maturity Method ASTM C1077 (2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation ASTM C1107/C1107M (2017) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) ASTM C1116/C1116M (2010a; R 2015) Standard Specification for Fiber-Reinforced Concrete ASTM C1157/C1157M (2017) Standard Performance Specification for Hydraulic Cement ASTM C1218/C1218M (2017) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete

ASTM C1240 (2020) Standard Specification for Silica Fume Used in Cementitious Mixtures

ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	(2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2018) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1778	(2016) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D5759	(2012) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D6690	(2015) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM E329	(2020) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1155	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with

REPAIR AND RENOVATION MATTHEW JONES HOUSE 100% DESIGN SUBMISSION Earth or Granular Fill Under Concrete Slabs ASTM E1745 (2017) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs CONCRETE REINFORCING STEEL INSTITUTE (CRSI) CRSI 10MSP (2018) Manual of Standard Practice CRSI RB4.1 (2016) Supports for Reinforcement Used in Concrete FOREST STEWARDSHIP COUNCIL (FSC) FSC STD 01 001 (2015) Principles and Criteria for Forest Stewardship NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) NIST PS 1 (2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood U.S. ARMY CORPS OF ENGINEERS (USACE) COE CRD-C 513 (1974) Corps of Engineers Specifications for Rubber Waterstops COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops U.S. GREEN BUILDING COUNCIL (USGBC) LEED NC (2009) Leadership in Energy and

LEED NC (2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 DEFINITIONS

- a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, and slag cement .
- b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.
- c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.
- d. "Supplementary cementing materials" (SCM) include coal fly ash, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.
- e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.

- f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.
- g. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.
- h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.
- i. "Pozzolan" is a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.
- j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G

Quality Control Personnel Certifications; G

Quality Control Organizational Chart

Laboratory Accreditation; G

Maturity Method Data

SD-02 Shop Drawings

Reinforcing Steel; G

SD-03 Product Data

Joint Sealants; (LEED NC)

Joint Filler; (LEED NC)

Formwork Materials

Recycled Aggregate Materials; (LEED NC) Cementitious Materials; (LEED NC) Vapor Retarder and Vapor Barrier Concrete Curing Materials Reinforcement; (LEED NC) Liquid Chemical Floor Hardeners and Sealers Admixtures Reinforcing Fibers Mechanical Reinforcing Bar Connectors Waterstops Local/Regional Materials; (LEED NC) Biodegradable Form Release Agent Pumping Concrete Finishing Plan Nonshrink Grout SD-04 Samples SD-05 Design Data Concrete Mix Design; G SD-06 Test Reports Concrete Mix Design; G Fly Ash Pozzolan Slag Cement Aggregates Compressive Strength Tests; G Air Content

Slump Tests

Water

SD-07 Certificates
Reinforcing Bars Welder Qualifications Safety Data Sheets Forest Stewardship Council (FSC) Certification Field Testing Technician and Testing Agency SD-08 Manufacturer's Instructions Liquid Chemical Floor Hardeners and Sealers Joint Sealants; (LEED NC)

Curing Compound

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Follow ACI 301, ACI 304R and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor retarder, vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.1.1 Concrete Mix Design

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, , and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture,

which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. For previously approved concrete mix designs used within the past twelve months, the previous mix design may be re-submitted without further trial batch testing if accompanied by material test data conducted within the last six months. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

1.6.2.1 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

1.6.3 Control Submittals

1.6.3.1 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.6.3.2 Safety Data Sheets

Submit Safety Data Sheets (SDS) for all materials that are regulated for hazardous health effects. SDS must be readily accessible during each work shift to employees when they are at the construction site.

1.6.4 Test Reports

1.6.4.1 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.

1.6.4.2 Slag Cement

Submit test results in accordance with ASTM C989/C989M for slag cement. Submit test results performed within 6 months of submittal date.

1.6.4.3 Aggregates

Submit test results in accordance with ASTM C33/C33M, or ASTM C330/C330M for lightweight aggregate, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.

1.6.5 Field Samples

1.6.6 Quality Control Plan

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. All quality control reports must be provided to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.6.7 Quality Control Personnel Certifications

The Contractor must submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

- a. CQC personnel responsible for inspection of concrete operations.
- b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.
- c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.
- 1.6.7.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.7.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

- a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI SP-2.
- b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.
- c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.
- 1.6.8 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and

experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.6.9 Laboratory Accreditation

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, the testing must comply with the following requirements:

- a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory competent in concrete materials who is competent in concrete materials and must sign all reports and designs.
- b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.
- c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing period or for 72 hours after installation:

- a. Supply 100 percent outside air 24 hours a day.
- b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.
- c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.
- 1.7.1 Submittals for Environmental Performance
 - a. Provide data indication the percentage of post-industrial pozzolan (fly ash, slag cement) cement substitution as a percentage of the full product composite by weight.
 - b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.
 - c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

- d. Provide product data stating the location where all products were manufactured
- e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.
- f. For projects using reusable formwork, provide data showing how formwork is reused.
- g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.
- h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500mile radius from the project site, if available from a minimum of three sources. Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

1.8.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.9 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

- a. Form-facing material in contact with concrete must be lumber, plywood, tempered concrete-form-grade hardboard, or . Submit product information on proposed form-facing materials if different from that specified herein.
- b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.

- c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.
- d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.
- e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.
- f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.
- g. Design formwork joints to inhibit leakage of mortar.
- h. Limit deflection of facing materials for concrete surfaces exposed to view to 1/400 of center-to-center spacing of facing supports.
- i. Do not use earth cuts as forms for vertical or sloping surfaces.
- j. Submit product information on proposed form-facing materials if different from that specified herein.
- k. Submit shop drawings for formwork, shoring, reshoring, and backshoring. Shop drawings must be signed and sealed by a licensed design engineer.
- Submit design calculations for formwork, shoring, reshoring, and backshoring. Design calculations must be signed and sealed by a licensed design engineer.
- m. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.
- n. Submit manufacturer's product data on form liner proposed for use with each formed surface.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.2 FORMWORK ACCESSORIES

- a. Use commercially manufactured formwork accessories, including ties and hangers.
- b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

- a. Use form ties with ends or end fasteners that can be removed without damage to concrete.
- b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.
- c. The breakback distance for ferrous ties must be at least 2 in. for Surface Finish-2.0 or Surface Finish-3.0, as defined in ACI 301.
- d. If the breakback distance is less than 3/4 in., use coated or corrosion-resistant ties.
- e. Submit manufacturer's data sheet on form ties.

2.2.2 Waterstops

Submit manufacturer's data sheet on waterstop materials and splices.

2.2.2.1 PVC Waterstop

Polyvinylchloride waterstops must conform to COE CRD-C 572.

2.2.2.2 Rubber Waterstop

Rubber waterstops must conform to COE CRD-C 513.

2.2.2.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops must conform to ASTM D471.

2.2.2.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water must conform to the following requirements when tested in accordance to ASTM D412: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Hardness must be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F must be 3 to 1 minimum.

2.2.3 Biodegradable Form Release Agent

a. Provide form release agent that is colorless, biodegradable, and

water-based, with a low (maximum of 55 grams/liter (g/1)) VOC content. A minimum of 85 percent of the total product must be biobased material.

- b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
- c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.
- d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.
- 2.2.4 Chamfer Materials

Use lumber materials with dimensions of $3/4 \ge 3/4$ in.

- 2.2.5 Construction and movement joints
 - a. Submit details and locations of construction joints in accordance with the requirements herein.
 - b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.
 - c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.
 - d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.
 - e. Make construction joints perpendicular to main reinforcement.
 - f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.
 - g. Submit location and detail of movement joints if different from those indicated in Contract Documents.
 - h. Submit manufacturer's data sheet on expansion joint materials.
 - i. Provide keyways where indicated in Contract Documents. Longitudinal keyways indicated in Contract Documents must be at least 1-1/2 in. deep, measured perpendicular to the plane of the joint.

2.2.6 Perimeter Insulation

Perimeter insulation must be polystyrene conforming to ASTM C578, Type II; polyurethane conforming to ASTM C591, Type II; or cellular glass conforming to ASTM C552, Type I or IV. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

2.2.7 Other Embedded items

Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

- 2.3 CONCRETE MATERIALS
- 2.3.1 Cementitious Materials

2.3.1.1 Portland Cement

- a. Unless otherwise specified, provide cement that conforms to ASTM C150/C150M Type II
- b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.
- c. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.
- d. Submit information along with evidence demonstrating compliance with referenced standards. Submittals must include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.
- e. Cementitious materials must be stored and kept dry and free from contaminants.

2.3.1.2 Fly Ash

- a. ASTM C618, Class F Class C, except that the maximum allowable loss on ignition must not exceed 6 percent.
- b. Fly ash content must be a minimum of 15 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.3.1.3 Slag cement

ASTM C989/C989M, Grade 100 . Slag content must be a minimum of 25 percent by weight of cementitious material.

2.3.1.4 Silica Fume

Silica fume must conform to ASTM C1240, including the optional limits on reactivity with cement alkalis. Silica fume may be furnished as a dry, densified material or as slurry. Proper mixing is essential to accomplish proper distribution of the silica fume and avoid agglomerated silica fume which can react with the alkali in the cement resulting in premature and extensive concrete damage. Supervision at the batch plant, finishing, and curing is essential. Provide at the Contractor's expense the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing

silica fume. This representative must be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume. A High Range Water Reducing admixture (HRWRA) must be used with silica fume.

2.3.1.5 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling ASR and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating ASR must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

- a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.
- b. The average particle size must not exceed 6 microns.
- c. The sum of SiO2 + Al2O3 + Fe2O3 must be greater than 77 percent.

2.3.2 Water

- a. Water or ice must comply with the requirements of ASTM C1602/C1602M.
- b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.
- c. Water must be potable ; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.
- d. Protect mixing water and ice from contamination during storage and delivery.
- e. Submit test report showing water complies with ASTM C1602/C1602M.
- f. When nonpotable source is proposed for use, submit documentation on effects of water on strength and setting time in compliance with ASTM C1602/C1602M.
- 2.3.3 Aggregate

2.3.3.1 Normal-Weight Aggregate

- a. Aggregates must conform to ASTM C33/C33M unless otherwise specified in the Contract Documents or approved by the contracting officer.
- b. Aggregates used in concrete must be obtained from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.
- c. Provide sand that is at least 50 percent natural sand.
- d. Store and handle aggregate in a manner that will avoid segregation and

prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.

- e. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33/C33M, and ASTM C1293 expansion data not more than 18 months old.
- 2.3.3.2 Lightweight Aggregate

Lightweight aggregate in accordance with ASTM C330/C330M.

2.3.3.3 Recycled Aggregate Materials

Use a minimum of percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.3.4 Admixtures

- a. Chemical admixtures must conform to ASTM C494/C494M.
- b. Air-entraining admixtures must conform to ASTM C260/C260M.
- c. Chemical admixtures for use in producing flowing concrete must conform to ASTM C1017/C1017M.
- d. Do not use calcium chloride admixtures
- e.
- f. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.
- g. Protect stored admixtures against contamination, evaporation, or damage.
- h. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.
- i. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Submit product data for concrete curing compounds. Submit manufactures instructions for placement of curing compound.

2.4.2 Nonshrink Grout

Nonshrink grout in accordance with ASTM C1107/C1107M.

2.4.3 Floor Finish Materials

2.4.3.1 Liquid Chemical Floor Hardeners and Sealers

- a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.
- b. Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.
- 2.4.3.2 Abrasive Aggregate for Nonslip Aggregate Finish
- 2.4.3.3 Dry Materials for Colored Wear-Resistant Finish
- 2.4.3.4 Aggregate for Heavy-Duty Wear-Resistant Finish
- 2.4.3.5 Aggregate for Heavy-Duty Floor Topping

Provide emery (or may be traprock or traprock-screenings) fine aggregates, as specified.

Provide emery that is packaged, factory-graded, crushed natural emery ore containing not less than 35-percent aluminum oxide and not less than 24-percent ferric oxide. Provide aggregate that is cubical or polyhedral in form and does not change its physical or chemical nature in the presence of moisture. Grade aggregate to a fineness modulus of 3.9 to 4.0, with 100 percent passing 3/8-inch sieve and not less than 95 percent retained on No. 100 sieve. Deliver emery in moisture-resistant bags.

Provide traprock that is packaged, crushed, natural, fine- to medium-grained igneous rock such as diabase, basalt, or black granite. Uniformly grade coarse aggregate with 100 percent passing 1/2-inch sieve, 30 to 50 percent passing 3/8-inch sieve, 0 to 15 percent passing No. 4 sieve, and 0 to 5 percent passing No. 8 sieve.

Provide fine aggregate using traprock that conforms to ASTM C33/C33M, except gradation. Grade fine aggregate within the following limits:

SIEVE	PERCENT PASSING
3/8 in.	100
No. 4	95 to 100
No. 8	65 to 80
No. 16	45 to 65
No. 30	25 to 45
No. 50	5 to 15
No. 100	0 to 5

Deliver traprock coarse aggregate and fine aggregate in moisture-resistant bags.

- 2.4.4 Expansion/Contraction Joint Filler
 - . Material must be 1/2 inch thick.
- 2.4.5 Joint Sealants
- 2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T.

2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type M, Grade NS, Class 25, Use T ...

2.4.5.3 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.4.5.4 Lubricant for Preformed Compression Seals

ASTM D2835.

2.4.6 Vapor Retarder and Vapor Barrier

ASTM E1745 Class C A polyethylene sheeting, minimum 10 mil thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Dovetail Anchor Slot

Preformed metal slot approximately 1 inch by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

- 2.5 CONCRETE MIX DESIGN
- 2.5.1 Properties and Requirements
 - a. Use materials and material combinations listed in this section and the contract documents.
 - b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

The minimum cementitious material content for concrete used in floors must meet the following requirements:

Nominal maximum size of aggregate, in.	Minimum cementitious material content, pounds per cubic yard
1-1/2	470
1	520
3/4	540
3/8	610

- c. Selected target slump must meet the requirements this section, the contract documents, and must not exceed 9 in. Concrete must not show visible signs of segregation.
- d. The target slump must be enforced for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.
- e. The nominal maximum size of coarse aggregate for a mixture must not exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.
- f. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must be in accordance with the requirements of the paragraph titled DURABILITY.
- g. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.
- h. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.
- i. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled DURABILITY for more details on exposure categories and their requirements.

	Minimum f'c psi	Exposure	Miscellaneous Requirements
Footings	4000at 28 days	S0 ; C0 ; W0 ; F0	Max. slump: 6 in.

	Minimum f'c psi	Exposure	Miscellaneous Requirements
Columns and walls	4000at 28 days	S0 ; C0 ; W0 ; F0	Nominal maximum aggregate size must be 1/2 in.
Beams and elevated slabs	5000 at 28 days	SO ; CO ; WO ; FO	Nominal maximum aggregate size must be 1/2 in.
Slabs-on-ground	4000at 28 days	S0 ; C0 ; W0 ; F0	
	4000at 28 days	S0 ; C0 ; W0 ; F0	

Minimum f'c psi	Exposure	Miscellaneous Requirements
	S0 ;	
4000at 28 days	C0 ;	
	WO ;	
	FO	

2.5.2 Durability

2.5.2.1 Alkali-Aggregate Reaction

Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

- a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.
- b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.
- c. Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Alkali content is calculated as follows: LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)
- 2.5.2.2 Freezing and Thawing Resistance
 - a. Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in Contract Documents:

Exposure class	Maximum w/cm*	Minimum f'c, psi	Air content	Additional Requirements
FO	N/A	2500		N/A
F1	0.55	3500	Depends on aggregate size	N/A

Exposure	Maximum	Minimum f'c, psi	Air	Additional
F2	w/cm* 0.45	4500	Depends on aggregate size	Requirements See limits on maximum cementitious material by mass
F3	0.40	5000	Depends on aggregate size	See limits on maximum cementitious material by mass
F3 plain concrete	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass

*The maximum w/cm limits do not apply to lightweight concrete.

 b. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must meet the requirements of the following table:

Nominal maximum	Total air content, percent*^			
aggregate size, in.	Exposure Class F2 and F3	Exposure Class F1		
3/8	7.5	6.0		
1/2	7.0	5.5		
3/4	6.0	5.0		
1	6.0	4.5		
1-1/2	5.5	4.5		
2	5.0	4.0		
3	5.5	3.5		

*Tolerance on air content as delivered must be plus/minus 1.5 percent. ^For f'c greater than 5000 psi, reducing air content by 1.0 percentage point is acceptable.

c. Submit documentation verifying compliance with specified requirements.

d. For sections of the structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture meets the requirements of the following table:

Cementitious material	Maximum percent of total cementitious material by mass*
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989/C989M	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans, slag cement, and silica fume	50^
Total of fly ash or other pozzolans and silica fume	35^

*Total cementitious material also includes ASTM C150/C150M, ASTM C595/C595M, ASTM C845/C845M, and ASTM C1157/C1157M cement. The maximum percentages above must include: i. Fly ash or other pozzolans present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement. ii. Slag cement present in ASTM C1157/C1157M or ASTM C595/C595M Type IS blended cement. iii. Silica fume conforming to ASTM C1240 present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement. ^Fly ash or other pozzolans and silica fume must constitute no more than 25 percent and 10 percent, respectively, of the total mass of the cementitious materials.

- 2.5.2.3 Corrosion and Chloride Content
 - a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.
 - b. Submit documentation verifying compliance with specified requirements.
 - c. Water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures must be determined for the concrete mixture by ASTM C1218/C1218M at age between 28 and 42 days.
 - d. The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Exposure class	Maximum <i>w/cm</i> *	Minimum f'c, psi	Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement	
Reinforced concrete				
CO	N/A	2500	1.00	
C1	N/A	2500	0.30	
C2	0.4	5000	0.15	
Prestressed concrete				
C0	N/A	2500	0.06	
C1	N/A	2500	0.06	
C2	0.4	5000	0.06	

*The maximum w/cm limits do not apply to lightweight concrete.

2.5.2.4 Sulfate Resistance

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	Maximum w/cm	Minimum f'c,	Required cementitious materials-types			Calcium chloride
		psi	ASTM C150/C150M	ASTM C595/C595M	ASTM C1157/C1157M	admixture
S0	N/A	2500	N/A	N/A	N/A	No restrictions
S1	0.50	4000	II*^	IP(MS); IS(<70)(MS); IT(MS)	MS	No restrictions
S2	0.45	4500	IV^	IP(HS); IS(<70)(HS); IT(HS)	HS	Not permitted
S3	0.45	4500	V + pozzolan or slag cement**	<pre>IP(HS)+ pozzolan or slag cement^; IS (<70)(HS) + pozzolan or slag cement^; IT (HS) + pozzolan or slag cement**</pre>	HS + pozzolan or slag cement**	Not permitted

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40. ** The amount of the specific source of the pozzolan or slag cement to

be used shall be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used shall not be less than the amount tested in accordance with ASTM C1012/C1012M and meeting the requirements maximum expansion requirements listed herein. ^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

- b. The maximum w/cm limits for sulfate exposure do not apply to lightweight concrete.
- c. Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure class	Maximum expansion when tested using ASTM C1012/C1012M				
	At 6 months	At 6 months	At 18 months		
S1	0.10 percent	N/A	N/A		
S2	0.05 percent	0.10 percent [^]	N/A		
\$3	N/A	N/A	0.10 percent		

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

2.5.2.5 Concrete Temperature

The temperature of concrete as delivered must not exceed $95^{\circ}F$.

- 2.5.2.6 Concrete permeability
 - a. Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.

Exposure class	Maximum w/cm*	Minimum f'c, psi	Additional minimum requirements
WO	N/A	2500	None
W1	0.5	4000	None

*The maximum w/cm limits do not apply to lightweight concrete.

b. Submit documentation verifying compliance with specified requirements.

2.5.3 Contractor's Option for Material Only

At the option of the Contractor, those applicable material sections of DOT RBS for Class strength concrete must govern in lieu of this specification for concrete. Do not change the selected option during the course of the work.

2.5.4 Trial Mixtures

Trial mixtures must be in accordance to ACI 301.

2.5.5 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

- a. Type and brand cement
- b. Cement and supplementary cementitious materials content in 94-pound bags per cubic yard of concrete
- c. Maximum size of aggregate
- d. Amount and brand name of admixtures
- e. Total water content expressed by water cementitious material ratio

2.6 REINFORCEMENT

- a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.
- b. When handling and storing coated reinforcement, use equipment and methods that do not damage the coating. If stored outdoors for more than 2 months, cover coated reinforcement with opaque protective material.
- c. Submit manufacturer's certified test report for reinforcement.
- d. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.
- e. Submit request with locations and details of splices not indicated in Contract Documents.
- f. Submit request to place column dowels without using templates.
- h. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.6.1 Reinforcing Bars

a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked A, Grade 60 ; or ASTM A996/A996M with the bars marked R, Grade 50, or marked A, Grade 60. Cold drawn wire used for spiral reinforcement must conform to ASTM A1064/A1064M.

с.

- d. Submit mill certificates for reinforcing bars.
- 2.6.1.1 Headed Reinforcing Bars

Headed reinforcing bars must conform to ASTM A970/A970M including Annex A1, and other specified requirements.

2.6.1.2 Bar Mats

- a. Bar mats must conform to ASTM A184/A184M.
- b. If coated bar mats are required, repair damaged coating as required in the paragraph titled GALVANIZED REINFORCING BARS EPOXY-COATED REINFORCING BARS and DUAL-COATED REINFORCING BARS.
- 2.6.1.3 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

- 2.6.2 Mechanical Reinforcing Bar Connectors
 - a. Provide 125 percent minimum yield strength of the reinforcement bar.
 - b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.
 - c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.
 - d. Submit data on mechanical splices demonstrating compliance with this paragraph.
- 2.6.3 Wire
 - a. Provide flat sheets of welded wire reinforcement for slabs and toppings.
 - b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.
 - c. Stainless steel wire must conform to ASTM A1022/A1022M.
 - d. Epoxy-coated wire must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color shall not be cause for rejection of epoxy-coated wire reinforcement.

- 2.6.4 Welded wire reinforcement
 - a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.
 - b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 12 in. apart in direction of principal reinforcement.
 - c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 16 in. apart in direction of principal reinforcement.
 - d. Epoxy-coated welded wire reinforcement must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement must be repaired in accordance with ASTM A884/A884M. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color shall not be cause for rejection of epoxy-coated welded wire reinforcement.
 - e. Stainless steel welded wire reinforcement must conform to ASTM A1022/A1022M.
 - f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area shall include repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.6.5 Reinforcing Bar Supports

a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b.

c. Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

d.

2.6.6 Reinforcing Fibers

2.6.6.1 Synthetic Fibers

In addition to the requirements specified above, provide fiber reinforced concrete in accordance with ASTM C1116/C1116M Type III, synthetic fiber reinforced concrete, and as follows. Synthetic reinforcing fibers must be

monofilament polypropylene fibers.

Provide fibers that have a specific gravity of 0.9, a minimum tensile strength of 70 ksi, graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Add fibers at the batch plant.

2.6.6.2 Steel Fibers

If steel fiber-reinforced concrete is specified in Contract Documents for providing shear resistance, steel fibers must be deformed and conform to ASTM A820/A820M. Steel fibers must have a length-to-diameter ratio of at least 50 and not exceed 100.

2.6.7 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A53/A53M.

- 2.6.8 Welding
 - a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.
 - b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.
 - c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.
 - d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.
- PART 3 EXECUTION

3.1 EXAMINATION

- a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.
- b. If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.
- c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

- a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.
- Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.
- 3.2.2 Subgrade Under Foundations and Footings
 - a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.
 - b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.
- 3.2.3 Subgrade Under Slabs on Ground
 - a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.
 - b. Previously constructed subgrade or fill must be cleaned of foreign materials
 - c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.
 - d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.
- 3.2.4 Edge Forms and Screed Strips for Slabs
 - a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.
 - b. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.
- 3.2.5 Reinforcement and Other Embedded Items
 - a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.
 - b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

- a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.
- b. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch. Place chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces.
- c. Provide formwork with clean-out openings to permit inspection and removal of debris.
- d. Inspect formwork and remove foreign material before concrete is placed.
- e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.
- f. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.
- g. Fasten form wedges in place after final adjustment of forms and before concrete placement.
- h. Provide anchoring and bracing to control upward and lateral movement of formwork system.
- i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.
- j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.
- k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.
- 1. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

- a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.
- b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.
- c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reshoring

- a. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.
- b. Install and remove reshores or backshores in accordance with accepted procedure.
- c. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a shore position or as indicated on formwork shop drawings.
- d. In multistory buildings, place reshoring or backshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads.

3.3.3 Reuse

- a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.
- b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.
- c. Remove leaked mortar from formwork joints before reuse.
- 3.3.4 Forms for Standard Rough Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.5 Forms for Standard Smooth Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

- 3.3.6 Form Ties
 - a. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the Contracting Officer.
 - b. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.
- 3.3.7 Forms for Concrete Pan Joist Construction

Pan-form units for one-way or two-way concrete joist and slab construction must be factory-fabricated units of the approximate section indicated. Units must consist of steel or molded fiberglass concrete form pans. Closure units must be furnished as required.

- 3.3.8 Tolerances for Form Construction
 - a. Construct formwork so concrete surfaces conform to tolerances in ACI 117.

- b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.
- c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.
- 3.3.9 Removal of Forms and Supports
 - a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.
 - b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.
 - c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.
 - d. Leave formwork and shoring in place to support construction loads and weight of concrete in beams, slabs, and other structural members until in-place required strength of concrete is reached.
 - e. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.
- 3.3.10 Strength of Concrete Required for Removal of Formwork

If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

- a. Tests of cast-in-place cylinders in accordance with ASTM C873/C873M. This option is limited to slabs with concrete depths from 5 to 12 in.
- b. Penetration resistance in accordance with ASTM C803/C803M.
- c. Pullout strength in accordance with ASTM C900.
- d. Maturity method in accordance with ASTM C1074. Submit maturity method data using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 WATERSTOP INSTALLATION AND SPLICES

- a. Provide waterstops in construction joints as indicated.
- b. Install formwork to accommodate waterstop materials. Locate waterstops in joints where indicated in Contract Documents. Minimize number of splices in waterstop. Splice waterstops in accordance with manufacturer's written instructions. Install factory-manufactured premolded mitered corners.
- c. Install waterstops to form a continuous diaphragm in each joint. Make adequate provisions to support and protect waterstops during progress of work. Protect waterstops protruding from joints from damage.

3.4.1 PVC Waterstop

Make splices by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. Reform waterstops at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled, must show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.4.2 Rubber Waterstop

Rubber waterstops must be spliced using cold bond adhesive as recommended by the manufacturer.

3.4.3 Thermoplastic Elastomeric Rubber Waterstop

Fittings must be shop made using a machine specifically designed to mechanically weld the waterstop. A portable power saw must be used to miter or straight cut the ends to be joined to ensure good alignment and contact between joined surfaces. Maintain continuity of the characteristic features of the cross section of the waterstop (for example ribs, tabular center axis, and protrusions) across the splice.

3.4.4 Hydrophilic Waterstop

Miter cut ends to be joined with sharp knife or shears. The ends must be adhered with adhesive.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

- a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.
- b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.
- c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
-		No. 5 bar, W31 or D31 wire, and smaller	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	1-1/2
		No. 11 bar and smaller	3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	1-1/2

d. Cast-in-place prestressed concrete members must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete	Member	Reinforcement	Specified
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	1
	All other	All	1-1/2

Concrete	Member	Reinforcement	Specified
Not exposed to weather or in	Slabs, joists, and walls	All	3/4
with ground	Beams, columns, and tension ties	Primary reinforcement	1-1/2
		Stirrups, ties, spirals, and hoops	1

e. Precast nonprestressed or prestressed concrete members manufactured under plant conditions must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Exposed to weather or in contact with ground	Walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/2
		No. 11 bars and smaller; W31 and D31 wire, and smaller; tendons and strands 1-1/2 in.	3/4
	All other	No. 14 and No. 18 bars; tendons larger than 1-1/2 in.	2
		No. 6 through No. 11 bars; tendons and strands larger than 5/8 in. diameter through 1-1/2 in.	1-1/2
		No. 5 bar, W31 or D31 wire, and smaller; tendons and strands 5/8 in. diameter and smaller	1-1/4

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/4
		Tendons and strands 1-1/2 in. diameter and smaller	3/4
		No. 11 bar, W31 or D31	5/8
	Beams, columns, pedestals, and tension ties	Primary reinforcement	Greater of bar diameter and 5/8 and need not exceed 1-1/2
		Stirrups, ties, spirals, and hoops	3/8

3.5.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.5.2 Vapor Retarder and Vapor Barrier

a. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12

inches and tape.

b. Remove torn, punctured, or damaged vapor retarder and vapor barrier material and provide with new vapor retarder and vapor barrier prior to placing concrete. Concrete placement must not damage vapor retarder and vapor barrier material.

3.5.3 Perimeter Insulation

Install perimeter insulation at locations indicated. Adhesive must be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.5.4 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Supports for coated or galvanized bars must also be coated with electrically compatible material for a distance of at least 2 inches beyond the point of contact with the bars.

3.5.5 Splicing

As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 2 inches.

3.5.6 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.5.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

- a. Provide fabrication tolerances that are in accordance with ACI 117.
- b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

- a. Bar lengths, depths, and bends beyond specified fabrication tolerances
- b. Bends or kinks not indicated on drawings or approved shop drawings
- c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.5.9 Placing Reinforcement

Place reinforcement in accordance with ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

- a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.
- b. Equip supports on ground and similar surfaces with sand-plates.
- c. Support welded wire reinforcement as required for reinforcing bars.
- d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.
- e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.
- f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.5.10 Spacing of Reinforcing Bars

- a. Spacing must be as indicated in the Contract Documents.
- b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.
- 3.5.11 Concrete Protection for Reinforcement

Additional concrete protection must be in accordance with the Contract Documents.

3.5.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

- 3.6.2 Mixing
 - a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.
 - b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F.
 - c. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and submitted water-cementitious material ratio are not exceeded and the required concrete strength is still met. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required.
 - d. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.
 - e. When fibers are used, add fibers together with the aggregates and never as the first component in the mixer. Fibers must be dispensed into the mixing system using appropriate dispensing equipment and procedure as recommended by the manufacturer.
3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete in accordance with ACI 301 Section 5.

3.7.1 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.7.2 Pumping

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.3 Cold Weather

Cold weather concrete must meet the requirements of ACI 301 unless otherwise specified. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.7.4 Hot Weather

Hot weather concrete must meet the requirements of ACI 301 unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.5 Bonding

Surfaces of set concrete at joints, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

- a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.
- b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.
- c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.
- 3.8 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.8.1 Mixing Equipment

Before concrete pours, designate Contractor-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.8.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.8.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.8.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Institute deconstruction and construction waste separation and recycling for use in manufacturer's programs. When such a program is not available, seek local recyclers to reclaim the materials.

- 3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES
- 3.9.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.9.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

- 3.9.3 Formed Surfaces
- 3.9.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.9.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.9.4 Smooth-Rubbed Finish

Provide a smooth-rubbed finish per ACI 301 Section 5 in the locations indicated.

3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile. Where straightedge measurements are specified, Contractor must provide straightedge.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.10.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.10.1.2 Steel Troweled

Use for floors intended as walking surfaces for reception of floor coverings . Finish concrete in accordance with ACI 301 Section 5 for a steel

troweled finish.

3.10.1.3 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.10.1.4 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by Round edges and joints with an edger having a radius of 1/8 inch.

3.10.2 Flat Floor Finishes

ACI 302.1R. Construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite Ff/FL Values for Various Construction Methods." ACI 117 for tolerance tested by ASTM E1155.

a. Specified Conventional Value:

Floor Flatness (Ff) 20 minimum Floor Levelness (FL) 15 minimum

b. Specified Industrial:

Floor Flatness (Ff) 30 minimum Floor Levelness (FL) 20 minimum

3.10.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:

- a. Key plan showing location of data collected.
- b. Results required by ASTM E1155.
- 3.10.2.2 Remedies for Out of Tolerance Work

Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

3.10.3 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 0.5 inch thick

transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.10.4 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.5 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.10.6 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

- 3.11 JOINTS
- 3.11.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Joints must be perpendicular to main reinforcement. Reinforcement must be continued and developed across construction joints. Locate construction joints as follows:

- 3.11.1.1 Maximum Allowable Construction Joint Spacing
 - a. In walls at not more than 60 feet in any horizontal direction.
 - b. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet.

3.11.1.2 Construction Joints for Constructability Purposes

- a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.
- b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.
- c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used

for slabs.

- 3.11.2 Isolation Joints in Slabs on Ground
 - a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - b. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.
- 3.11.3 Contraction Joints in Slabs on Ground
 - a. Provide joints to form panels as indicated.
 - b. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.
 - c. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.
 - e. Sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.
- 3.11.4 Sealing Joints in Slabs on Ground
 - a. Contraction and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.
 - b. Sealed groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.12 CONCRETE FLOOR TOPPING

3.12.1 Standard Floor Topping

Provide topping for treads and platforms of metal steel stairs and elsewhere as indicated.

- 3.12.1.1 Preparations Prior to Placing
 - a. When topping is placed on a green concrete base slab, screed surface of base slab to a level not more than 1-1/2 inches nor less than 1 inch below required finish surface. Remove water and laitance from surface of base slab before placing topping mixture. As soon as water ceases to rise to surface of base slab, place topping.

- b. When topping is placed on a hardened concrete base slab, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from base slab surface, leaving a clean surface. Prior to placing topping mixture, 2-1/2-inches minimum, slab surface must be dampened and left free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Do not allow cement grout to set or dry before topping is placed.
- c. When topping is placed on a metal surface, such as metal pans for steel stairs, remove dirt, loose material, oil, grease, asphalt, paint, and other contaminants from metal surface.

3.12.1.2 Placing

Spread standard topping mixture evenly on previously prepared base slab or metal surface, brought to correct level with a straightedge, and struck off. Topping must be consolidated, floated, checked for trueness of surface, and refloated as specified for float finish.

3.12.1.3 Finishing

Give trowel finish standard floor topping surfaces.

Give other finishes standard floor topping surfaces as indicated.

3.12.2 Heavy-Duty Floor Topping

Provide topping where indicated.

3.12.2.1 Heavy-duty Topping Mixture

Provide mixture that consists of 1 part portland cement and 2-1/2 parts emery aggregate or 1 part fine aggregate and 1-1/2 parts traprock coarse aggregate, by volume. Exact proportions of mixture must conform to recommendations of aggregate manufacturer. Mixing water must not exceed 3-1/4 gallons per 94-pound sack of cement including unabsorbed moisture in aggregate. Maximum slump must be 1 inch.

- 3.12.2.2 Base Slab
 - a. Screed surface of slab to a level no more than 1-1/2 inches nor less than 1 inch below grade of finished floor.
 - b. Give slab a scratch finish as specified.
 - c. Preparations prior to placing.

Remove dirt, loose material, oil, grease, asphalt, paint and other contaminants from base slab surface. Prior to placing topping mixture, dampen slab surface and leave free of standing water. Immediately before topping mixture is placed, broom a coat of neat cement grout onto surface of slab. Allow cement grout to set or dry before topping mixture is placed.

3.12.2.3 Placing

Spread heavy-duty topping mixture evenly on previously prepared base slab, and bring to correct level with a straightedge, and strike off. Provide topping that is consolidated, floated, and checked for trueness of surface

as specified for float finish, except that power-driven floats is the impact type.

3.12.2.4 Finishing

Give trowel finish heavy-duty floor topping surfaces. Provide trowel finish as specified, except that additional troweling after first power troweling must be not less than three hand-troweling operations.

3.13 CURING AND PROTECTION

Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs, including .

3.13.1 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.13.2 Curing Periods

ACI 301 Section 5, except 10 days for retaining walls, pavement or chimneys. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.13.3 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.13.4 Curing Unformed Surfaces

- a. Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.
- c. Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.13.5 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.13.6 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.13.7 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

- 3.14 FIELD QUALITY CONTROL
- 3.14.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.14.2 Testing

3.14.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.14.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.14.2.3 Compressive Strength Tests

ASTM C39/C39M. Make six 6 inch by 12 inch test cylinders for each set of tests in accordance with ASTM C31/C31M, ASTM C172/C172M and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, two cylinders at 56 days and hold two cylinder in reserve. Take samples for strength tests of each mix design of and for _____ concrete placed each day not less than once a day, nor less than once for each 100 cubic yards of concrete for the first 500 cubic yards, then every 500 cubic yards thereafter, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days . Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301. Retest locations represented by erratic core strengths. Where retest does not meet concrete compressive strength requirements submit a mitigation or remediation plan for review and approval by the contracting officer. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.14.2.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete . Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.14.2.5 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

- a. Failure to meet compressive strength tests as evaluated.
- b. Reinforcement not conforming to requirements specified.
- c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
- d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.
- e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.
- f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the contracting officer.

3.14.2.6 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement.

Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor must be responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.14.2.7 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

- a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.
- b. Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.
- c. Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.
- d. Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.15 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared which includes recommendations for repair, removal or remediation must be submitted to the Contracting Officer for approval before any corrective work is accomplished.

3.15.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.02 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

3.15.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.15.3 Failure of Quality Assurance Test Results

Proposed mitigation efforts by the Contractor must be approved by the Contracting Officer prior to proceeding.

-- End of Section --

SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE 05/14

PART 1 GENERAL

1.1 SUMMARY

Perform all work in accordance with ACI 318.

1.2 UNIT PRICES

1.2.1 Concrete Payment

Payment will cover all costs associated with[manufacturing,] furnishing, delivering, placing, finishing, and curing of concrete for the various items of the schedule, including the cost of all formwork. Payment for concrete, for which payment is made as a lump sum, [is] [is not] to be included in this unit price payment item. Payment for grout, preformed expansion joints, field-molded sealants, waterstops, reinforcing steel bars or wire reinforcement [is] [is not] to be included in this unit price payment item.

1.2.2 Measurement

Concrete will be measured for payment on the basis of the actual volume of concrete within the pay lines of the structures as indicated. Measurement of concrete placed against the sides of any excavation without the use of intervening forms will be made only within the pay lines of the structure. No deductions will be made for rounded or beveled edge, for space occupied by metal work, for electrical conduits or timber, or for voids or embedded items that are either less than 5 cubic feet in volume or 1 square foot in cross section.

1.2.3 Unit of Measure

Unit of measure: cubic yard.

1.3 REFERENCES

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

AMERICAN CONCRETE INSTITUTE (ACI)

ACI	117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI	301	(2016) Specifications for Structural Concrete
ACI	302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI	304R	(2000; R 2009) Guide for Measuring,

	Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete
ACI SP-66	(2004) ACI Detailing Manual
ASTM INTERNATIONAL (AST	М)
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2023) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2023) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2023) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2023) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2019; E 2022) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2023) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2017) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D98	(2015) Calcium Chloride
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property – Effect of Liquids
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete

Paving and Structural Construction

- ASTM E96/E96M (2022a; E 2023) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
- ASTM E1155 (2020) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
- ASTM E1155M (2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)
- ASTM E1643 (2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
- ASTM E1745 (2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- ASTM E1993/E1993M (1998; R 2020) Standard Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE	CRD-C	513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE	CRD-C	572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

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

40 CFR 247Comprehensive Procurement Guideline for
Products Containing Recovered Materials

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G[, []]

SD-03 Product Data

Air-Entraining Admixture Accelerating Admixture Water-Reducing or Retarding Admixture

Curing Materials Expansion Joint Filler Strips, Premolded Joint Sealants - Field Molded Sealants Waterstops Chemical Floor Hardener Batching and Mixing Equipment Conveying and Placing Concrete Formwork Mix Design Data; G[, [___]] Ready-Mix Concrete Curing Compound Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

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Aggregates
Concrete Mixture Proportions; G[, [___]]
Measurement of Floor Tolerances
Compressive Strength Testing; G[, [___]]
Slump; G[, [___]]
Air Content
Water
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SD-07 Certificates

Cementitious Materials Pozzolan CPG for recycled materials or appropriate Waiver Form Aggregates Delivery Tickets

SD-08 Manufacturer's Instructions

Chemical Floor Hardener Curing Compound

1.5 QUALITY ASSURANCE

Indicate specific locations of [Concrete Placement] [Forms] [Steel Reinforcement] [Accessories] [Expansion Joints] [Construction Joints] [Contraction Joints] [Control Joints] on installation drawings and include, but not be limited to, square feet of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

1.5.1 Regulatory Requirements

The state statutory and regulatory requirements: [____] form a part of this specification to the extent referenced. Submit CPG for recycled materials or appropriate Waiver Form.

1.5.2 Flatness and Levelness of Floor Slabs

Conduct floor flatness and levelness test, (FF and FL respectively), on floor slabs in accordance with the provisions set forth in ASTM E1155M or ASTM E1155. Make floor tolerance measurements by the approved laboratory and inspection service within 24 hours after completion of final troweling operation and before forms and shores have been removed. Provide results of floor tolerance tests, including formal notice of acceptance or rejection of the work, to the Contracting Officer within 24 hours after

data collection.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The Government retains the option to sample and test [joint sealer, joint filler material, waterstop,] aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Obtain samples of aggregates at the point of batching in accordance with ASTM D75/D75M. Sample concrete in accordance with ASTM C172/C172M. Determine slump and air content in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, when cylinders are molded. Prepare, cure, and transport compression test specimens in accordance with ASTM C31/C31M. Test compression test specimens in accordance with ASTM C39/C39M. Take samples for strength tests not less than once each shift in which concrete is produced [from each strength of concrete required]. Provide a minimum of four 6 x 12 inch or six 4 x 8 inch specimens from each sample; two 6 x 12 inch or three 4 x 8 inch to be tested at 28 days (90 days if pozzolan or slag cement is used) for acceptance. Two 6×12 inch or three 4×8 inch will be tested at 7 days for information.

2.1.1 Strength

Acceptance test results are the average strengths of two 6 x 12 inch or three 4 x 8 inch specimens tested at 28 days (90 days if pozzolan or slag cement is used). The strength of the concrete is considered satisfactory so long as the average of all three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, and no individual acceptance test result falls below f'c by more than 500 psi.

2.1.2 Construction Tolerances

Apply a Class "C" finish to all surfaces except those specified to receive a Class "D" finish. Apply a Class "D" finish to all post-construction surfaces which will be permanently concealed. Surface requirements for the classes of finish required are as specified in ACI 117.

2.1.3 Concrete Mixture Proportions

Concrete mixture proportions are the responsibility of the Contractor. Mixture proportions must include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per yard of concrete. Provide materials included in the mixture proportions of the same type and from the same source as will be used on the project. The specified compressive strength f'c is [3,000] [] psi at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate is [3/4] [1] [1-1/2] inch, in accordance with ACI 304R. The air content must be between 4.5 and 7.5 percent with a slump between 2and 5 inches. The maximum water-cementitious material ratio is [0.50]]. Submit the applicable test reports and mixture proportions that [will produce concrete of the quality required, ten days prior to placement of concrete.

2.1.4 Slag Cement

Slag Cement must conform to ASTM C989/C989M, [Grade 80], [Grade 100] [or] [Grade 120].

2.2 MATERIALS

Submit manufacturer's literature from suppliers which demonstrates compliance with applicable specifications for the specified materials.

2.2.1 Cementitious Materials

Submit Manufacturer's certificates of compliance, accompanied by mill test reports, attesting that the concrete materials meet the requirements of the specifications in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Also, certificates for all material conforming to EPA's Comprehensive Procurement Guidelines (CPG), in accordance with 40 CFR 247. Provide cementitious materials that conform to the appropriate specifications listed:

2.2.1.1 Portland Cement

ASTM C150/C150M, Type [I][II][III][V], [low alkali] [including false set requirements] with tri-calcium aluminates (C3A) content less than 10 percent and a maximum cement-alkali content of 0.80 percent Na2Oe (sodium oxide) equivalent.

[2.2.1.2 Blended Hydraulic Cement

Provide blended cement conforming to ASTM C595/C595M and ASTM C1157/C1157M, Type IP, IL or IS, including the optional requirement for mortar expansion [and sulfate soundness] and consist of a mixture of ASTM C150/C150M Type I, or Type II cement and a complementary cementing material. The slag added to the Type IS blend must be ASTM C989/C989M ground granulated blast-furnace slag. The pozzolan added to the Type IP blend must be ASTM C618 Class F, interground with the cement clinker. Provide the manufacturer's written statement that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. Do not change the percentage and type of mineral admixture used in the blend from that submitted for the aggregate evaluation and mixture proportioning.

]2.2.1.3 Pozzolan

Provide pozzolan that conforms to ASTM C618, Class F, including requirements of Tables 1A and 2A.

2.2.2 Aggregates

For fine and coarse aggregates meet the quality and grading requirements of ASTM C33/C33M[and test and evaluate for alkali-aggregate reactivity in accordance with ASTM C1260. Perform evaluation of fine and coarse aggregates separately and in combination, matching the proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.08 percent at 28 days after casting. If the test data indicates an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform the additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated

blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass]. Submit certificates of compliance and test reports for aggregates showing the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

2.2.3 Admixtures

Provide admixtures, when required or approved, in compliance with the appropriate specification listed. Retest chemical admixtures that have been in storage at the project site, for longer than 6 months or that have been subjected to freezing, at the expense of the Contractor at the request of the Contracting Officer and will be rejected if test results are not satisfactory.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture that meets the requirements of ASTM C260/C260M.

[2.2.3.2 Accelerating Admixture

Provide calcium chloride meeting the requirements of ASTM D98. Other accelerators must meet the requirements of ASTM C494/C494M, Type C or E.

]2.2.3.3 Water-Reducing or Retarding Admixture

Provide water-reducing or retarding admixture meeting the requirements of ASTM C494/C494M, Type A, B, or D. [High-range water reducing admixture Type F [or G] may be used only when approved, approval being contingent upon particular placement requirements as described in the Contractor's Quality Control Plan.]

2.2.4 Water

Mixing and curing water in compliance with the requirements of ASTM C1602/C1602M; [potable, and] free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

[2.2.5 Reinforcing Steel

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Provide welded steel wire reinforcement conforming to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301 and ACI SP-66. Provide mechanical reinforcing bar connectors in accordance with ACI 301 and provide 125 percent minimum yield strength of the reinforcement bar.

][2.2.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded of sponge rubber conforming to ASTM D1752, Type I.

][2.2.7 Joint Sealants - Field Molded Sealants

Conform to ASTM C920, Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Provide

polyethylene tape, coated paper, metal foil, or similar type bond breaker materials. The backup material needs to be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, clean the joint of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

][2.2.8 Formwork

Design and engineer the formwork as well as its construction in accordance with ACI 301 Section 2 and 5 and ACI 347R. Fabricate of wood, steel, or other approved material. Submit formwork design prior to the first concrete placement.

][2.2.9 Form Coatings

Provide form coating in accordance with ACI 301.

][2.2.10 Vapor Retarder[and VaporBarrier]

[ASTM E1745 Class [C] [A] [B] polyethylene sheeting, minimum [10] [15] mil thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.] [ASTM E1745 Class [C] [A] [B] polyethylene sheeting, minimum [10] [15] mil thickness or ASTM E1993/E1993M bituminous membrane or other equivalent material with a maximum permeance rating of 0.01 perms per ASTM E96/E96M.]

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

]2.2.11 Curing Materials

Provide curing materials in accordance with ACI 301, Section 5.

2.3 READY-MIX CONCRETE

Provide ready-mix concrete with mix design data conforming to ACI 301 Part 4. Submit delivery tickets in accordance with ASTM C94/C94M for each ready-mix concrete delivery, include the following additional information: .

- a. Type and brand cement
- b. Cement content in 94-pound bags per cubic yard of concrete
- c. Maximum size of aggregate
- d. Amount and brand name of admixture
- e. Total water content expressed by water cementitious material ratio
- 2.4 ACCESSORIES

2.4.1 Waterstops

2.4.1.1 PVC Waterstop

Polyvinylchloride waterstops conforming to COE CRD-C 572.

2.4.1.2 Rubber Waterstop

Rubber waterstops conforming to COE CRD-C 513.

2.4.1.3 Thermoplastic Elastomeric Rubber Waterstop

Thermoplastic elastomeric rubber waterstops conforming to ASTM D471.

2.4.1.4 Hydrophilic Waterstop

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water conforming to ASTM D412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum. Minimum hardness of 50 on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F; 3 to 1 minimum.

2.4.2 Chemical Floor Hardener

Provide hardener which is a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

2.4.3 Curing Compound

Provide curing compound conforming to ASTM C309. Submit manufactures instructions for placing curing compound.

PART 3 EXECUTION

3.1 PREPARATION

Prepare construction joints to expose coarse aggregate. The surface must be clean, damp, and free of laitance. Construct ramps and walkways, as necessary, to allow safe and expeditious access for concrete and workmen. Remove snow, ice, standing or flowing water, loose particles, debris, and foreign matter. Satisfactorily compact earth foundations. Make spare vibrators available. Placement cannot begin until the entire preparation has been accepted by the Government.

3.1.1 Embedded Items

Secure reinforcement in place after joints, anchors, and other embedded items have been positioned. Arrange internal ties so that when the forms are removed the metal part of the tie is not less than 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Prepare embedded items so they are be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete is permitted only when specifically authorized or directed. Provide all equipment needed to place, consolidate, protect, and cure the concrete at the placement site and in good operating condition.

3.1.2 Formwork Installation

Forms must be properly aligned, adequately supported, and mortar-tight. Provide smooth form surfaces, free from irregularities, dents, sags, or holes when used for permanently exposed faces. Chamfer all exposed joints

and edges , unless otherwise indicated.

[3.1.3 Vapor Retarder[and Vapor Barrier] Installation

Install in accordance with ASTM E1643. Apply vapor retarder[andbarrier] over gravel fill. Lap edges not less than 12 inches. Seal all joints with pressure-sensitive adhesive not less than 2 inches wide. Protect the vapor barrier at all times to prevent injury or displacement prior to and during concrete placement.

-]3.1.4 Production of Concrete
- 3.1.4.1 Ready-Mixed Concrete

Provide ready-mixed concrete conforming to ASTM C94/C94M except as otherwise specified.

3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Conform to ASTM C685/C685M.

[3.1.4.3 Batching and Mixing Equipment

The option of using an on-site batching and mixing facility is available. The facility must provide sufficient batching and mixing equipment capacity to prevent cold joints. Submit the method of measuring materials, batching operation, and mixer for review, and manufacturer's data for batching and mixing equipment demonstrating compliance with the applicable specifications. [Provide an Onsite Plant conforming to the requirements of either ASTM C94/C94M or ASTM C685/C685M.]

][3.1.5 Waterstops

Install and splice waterstops as directed by the manufacturer.

]3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301, Section 5.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R

- 3.3 FINISHING
- 3.3.1 Temperature Requirement

Do not finish or repair concrete when either the concrete or the ambient temperature is below 50 degrees F.

3.3.2 Finishing Formed Surfaces

Remove all fins and loose materials , and surface defects including filling of tie holes. Repair all honeycomb areas and other defects. Remove all unsound concrete from areas to be repaired. Ream or chip surface defects

greater than 1/2 inch in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete and fill with dry-pack mortar. Brush-coat the prepared area with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filling with mortar or concrete. Use a blend of portland cement and white cement in mortar or concrete for repairs to all surfaces permanently exposed to view so that the final color when cured is the same as adjacent concrete.

3.3.3 Finishing Unformed Surfaces

Finish unformed surfaces in accordance with ACI 301, Section 5.

FINISH	LOCATION
Float	
Trowel	
Broom or Belt	

3.3.3.1 Flat Floor Finishes

In accordance with ACI 302.1R, construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite FF/FL Values for Various Construction Methods." ACI 117 for tolerances tested by ASTM E1155M or ASTM E1155. These requirements are based upon the latest FF/FL method.

3.3.3.1.1 Floor Slabs

Conform floor slabs on grade to the following ACI F-number requirements unless noted otherwise:

Specified Overall Values	FF30/FL23	minimum	[FF	/FL]
Minimum Local Values	FF17/FL15	minimum	[FF	/FL]

3.3.3.1.2 Subject to Vehicular Traffic

Conform floor slabs on grade subject to vehicular traffic or receiving thin-set flooring to the following ACI F-number requirements:

Specified Overall Values	FF35/FL25	minimum	[FF	_/FL]
Minimum Local Values	FF25/FL17	minimum	[FF	_/FL]

3.3.3.2 Measurement of Floor Tolerances

Test floor slabs within 24 hours of the final troweling. Submit test results to Contracting Officer within 12 hours after collecting data. Floor flatness inspector mustl provide a tolerance report which includes:

- a. Name of Project
- b. Name of Contractor
- c. Date of Data Collection

- d. Date of Tolerance Report
- e. A Key Plan Showing Location of Data Collected
- f. Results Required by ASTM E1155M ASTM E1155

[3.3.3.3 Expansion and Contraction Joints

Make expansion and contraction joints in accordance with the details shown or as otherwise specified. Provide 1/2 inch thick transverse expansion joints where new work abuts an existing concrete. Provide expansion joints at a maximum spacing of 30 feet on center in sidewalks [and at a maximum spacing of [____] feet in slabs], unless otherwise indicated. Provide contraction joints at a maximum spacing of [6] [___] linear feet in sidewalks [and at a maximum spacing of [6] [___] feet in slabs], unless otherwise indicated. Cut contraction joints at a minimum of [1] [___] inch(es) deep with a jointing tool after the surface has been finished.

13.4 CURING AND PROTECTION

Cure and protect in accordance with ACI 301, Section 5.

3.5 FORM WORK

Provide form work in accordance with ACI 301, Section 2 and Section 5.

3.5.1 Removal of Forms

Remove forms in accordance with ACI 301, Section 2.

3.6 STEEL REINFORCING

Reinforcement must be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.6.1 Fabrication

Shop fabricate steel reinforcement in accordance with ACI 318 and ACI SP-66. Provide shop details and bending in accordance with ACI 318 and ACI SP-66.

3.6.2 Splicing

Perform splices in accordance with ACI 318 and ACI SP-66.

3.6.3 Supports

Secure reinforcement in place by the use of metal or concrete supports, spacers, or ties.

3.7 EMBEDDED ITEMS

Before placing concrete, take care to determine that all embedded items are firmly and securely fastened in place. Provide embedded items free of oil and other foreign matter, such as loose coatings of rust, paint and scale. Embedding of wood in concrete is permitted only when specifically authorized or directed.

3.8 CHEMICAL FLOOR HARDENER

Apply Chemical Floor Hardener where indicated, after curing and drying concrete surface. Dilute liquid hardener with water and apply in three coats. First coat is one-third strength, second coat one-half strength, and third coat two-thirds strength. Apply each coat evenly and allow it to dry 24 hours before applying next coat. Apply proprietary chemical hardeners in accordance with manufacturer's printed directions.

3.9 TESTING AND INSPECTING

Report the results of all tests and inspections conducted at the project site informally at the end of each shift. Submit written reports weekly. Deliver within three days after the end of each weekly reporting period. See Section 01 45 00 QUALITY CONTROL.

3.9.1 Field Testing Technicians

The individuals who sample and test concrete must have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.9.2 Preparations for Placing

Inspect foundation or construction joints, forms, and embedded items in sufficient time prior to each concrete placement to certify that it is ready to receive concrete.

- 3.9.3 Sampling and Testing
 - a. Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders.
 - b. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 100 cubic yards of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Conform test specimens to ASTM C31/C31M. Perform compressive strength testing conforming to ASTM C39/C39M.
 - c. Test slump at the [plant] [site of discharge] for each design mix in accordance with ASTM C143/C143M. Check slump [once] [twice] during each shift that concrete is produced [for each strength of concrete required].
 - d. Test air content for air-entrained concrete in accordance with ASTM C231/C231M. Test concrete using lightweight or extremely porous aggregates in accordance with ASTM C173/C173M. Check air content at least [once] [twice] during each shift that concrete is placed [for each strength of concrete required].
 - e. Determine temperature of concrete at time of placement in accordance with ASTM C1064/C1064M. Check concrete temperature at least [once] [twice] during each shift that concrete is placed [for each strength of concrete required].

3.9.4 Action Required

3.9.4.1 Placing

Do not begin placement until the availability of an adequate number of acceptable vibrators, which are in working order and have competent operators, has been verified. Discontinue placing if any lift is inadequately consolidated.

3.9.4.2 Air Content

Whenever an air content test result is outside the specification limits, adjust the dosage of the air-entrainment admixture prior to delivery of concrete to forms.

3.9.4.3 Slump

Whenever a slump test result is outside the specification limits, adjust the batch weights of water and fine aggregate prior to delivery of concrete to the forms. Make the adjustments so that the water-cementitious material ratio does not exceed that specified in the submitted concrete mixture proportion and the required concrete strength is still met.

-- End of Section --

SECTION 04 01 20.70

UNIT MASONRY CLEANING AND RESTORATION 11/15

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(201	5;	Suppl	12	2002-20	016)	Doc	cumen	tation	of
	the	Thr	reshol	ld	Limit	Valu	es	and	Biolog	gical
	Expo	sur	re Inc	dic	ces					

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM C1196	(2014) Standard Test Method for In Situ Compressive Stress Within Solid Unit Masonry Esitmated Using Flatjack Measurements
ASTM C1197	(2014) Standard Test Method for In Situ Measurement of Masonry Deformability Properties Using the Flatjack Method
ASTM C1324	(2015) Standard Test Method for Examination and Analysis of Hardened Masonry Mortar
ASTM C1364	(2016; E 2016) Standard Specification for Architectural Cast Stone
ASTM C1531	(2015) Standard Test Methods for In Situ Measurement of Masonry Mortar Joint Shear Strength Index
ASTM C1601	(2014) Standard Test Method for Field Measurement of Water Penetration of Masonry Wall Surfaces
ASTM C170/C170M	(2017) Standard Test Method for Compressive Strength of Dimension Stone
ASTM C1713	(2012) Standard Specification for Mortars for the Repair of Historic Masonry
ASTM C216	(2017) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C34	(2013) Structural Clay Load-Bearing Wall Tile
ASTM C67	(2016) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C926	(2016b) Standard Specification for Application of Portland Cement-Based Plaster
ASTM E2260	(2012) Standard Guide for Repointing (Tuckpointing) Historic Masonry
ASTM E2659	(2015) Standard Practice for Certificate Programs
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials

NATIONAL PARK SERVICE (NPS)

NPS Hist Prop	(1995) National Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings
NDG TDG Duite 5 1	Bullaings

NPS TPS Brief 1 (2000) Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings

NPS TPS Brief 2 (1998) Repointing Mortar Joints in Historic Masonry Buildings

THE MASONRY SOCIETY (TMS)

TMS MSJC (2011) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

1.2 DEFINITIONS

Terms are defined below as applicable to this project.

1.2.1 Aggregates

The sand component of mortar.

1.2.2 Biocides

A chemical treatment that inhibits, deters, or controls organic growth. Such growth is typically removed by cleaning following biocide treatment..

1.2.3 Binder

The component of mortar that binds together the aggregate particles into a cohesive material.

1.2.4 Dispersed Lime Crack Injection

A repair method in which dispersed lime material is injected into small cracks ranging in width from hairline to 1/8 in by use of needle or syringe.

1.2.5 Consolidant

A chemical product meant to strengthen loose or deteriorated stone.

1.2.6 Dutchman

A repair method in which deteriorated stone is removed in part and replaced with salvaged, harvested or new stone to make a seamless patch.

1.2.7 Harvested

Units removed from inconspicuous areas of the building.

1.2.8 In situ

A term referencing a repair procedure in which the masonry units and mortar remain in place and are repaired without removal from the wall system

1.2.9 Joint Sealant

A flexible, chemical product that is used to create a weather-tight seal at the boundary of masonry units with other units or dissimilar materials.

1.2.10 Lime Wash

A protective surface treatment comprised of calcium hydroxide particles in suspension in water, along with small amounts of calcium carbonate, silica particles and other minerals.

1.2.11 Mockup

Specific area on the building approved by Contracting Officer to demonstrate the contractor's ability to apply, match and install specified materials.

1.2.12 Mortar

A mixture of binders, aggregates, and pigments used for reconstruction, repointing or stucco applications.

1.2.13 New Elements

New, non-historic materials added to masonry structures to aid in their ability to resist loads (typically seismic) or to resist water infiltration.

1.2.14 Patch

The use of substitute repair materials to treat damaged or deteriorated

masonry units in situ.

1.2.15 Remediate

An intervention of a historic masonry structure and its component materials with the intent to maintain the original fabric to the greatest extent possible.

1.2.16 Remove

Specifically for historic masonry materials, the term means to detach an item from existing construction to the limits indicated.

1.2.17 Replace

To reinstall an item in its original position (or where indicated) after remedial treatment, or to duplicate and reinstall an entire item with new material; with the original item serving as the pattern for creating the duplicate.

1.2.18 Repoint

To remove existing mortar joints to the specified depth and replace with a mortar that matches in color, texture, and performance with water vapor transmission, bond, hardness, and flexibility compatible with original mortar, as assessed in accordance with ASTM C1713.

1.2.19 Retool

A repair method in which a chisel is used to re-create the surrounding stone texture finish by removing loose pieces of stone.

1.2.20 Stucco

A mixture of binders and aggregates, sometimes including animal hair or fibers used for the repair treatment of existing stucco.

1.2.21 Surface Treatment

The application of traditional materials or contemporary chemical products to the surface of masonry to provide protection to the masonry units and mortar and/or reduce water infiltration.

1.2.22 Test Panel

Specific area on the building approved by the Contracting Officer to demonstrate individual applicator competency and workmanship proficiency prior to the start of restoration work.

1.2.23 Tuckpointing

Often called skim-coating, an American practice of surface repairing mortar joints without the required removal of existing deteriorated mortar beneath. This practice is not recommended for mortar joint repair work on historic masonry. There is also an acceptable British form of tuckpointing practice that involves careful thin penciling of smaller joints within larger ones to give the wall the appearance of an ashlar finish.

1.2.24 Water Repellent

A surface-applied chemcial intended to reduce liquid water entry into a masonry wall without significantly affecting the vapro transmission properties of the original material.

1.2.25 Wall System

A term used to address the fact that masonry structures are comprised of different materials but function holistically, requiring that all restoration and cleaning process take into account the implications of the treatment to the adjacent materials and the building as a whole.

1.2.26 Masonry Treatment Requirement (MTR)

Defined treatments that are required by the specification (contract) documents for project specific repairs to masonry.

1.2.27 Saturated Surface Dry (SSD)

Condition of the wall surface after water has been applied sufficient to saturate more than the surface, then allowed to dry until the surface is dry but the body of the masonry still has moisture.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

Prior to beginning the work of this Section, convene a meeting with the Contracting Officer's Representative(s) to review the requirements of the Quality Control Plan, Project Training Program, installation procedures, location of required mockup areas, and all job conditions and processes. All subcontracting firms involved with this work shall participate in this meeting.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals
 Quality Control Plan; G
 Qualifications; G
SD-02 Shop Drawings; G
 Photographic Documentation
 Flashing And Accessories; G
SD-03 Product Data

Qualifications Cleaning and Restoration Methods; G Cleaning Materials; G

Biocides Replacement Mortar And Stucco; G Mortar Mix; G Water Repellents Infiltration; G Stone Consolidants; G Flashings; G

SD-04 Samples

Mock-ups; G

SD-06 Test Reports

Testing and Matching Existing Sealants for Asbestos and PCBs

SD-07 Certificates

Repair Materials

1.5 QUALITY CONTROL

1.5.1 Quality Control Plan

Prior to beginning restoration and cleaning work, submit a written Quality Control Plan. Include a separate section in the overall project Quality Control Plan specifically addressing this restoration and cleaning work. Do not proceed without written approval of the Quality Control Plan. At a minimum, include the following items in the Quality Control Plan:

- a. Describe methods of dust containment during the work specific to the work of this section.
- b. Describe the methods of protecting surrounding masonry, windows, doors, roof, and building trim as well as surrounding landscape. Provide drawings of protection when requested.
- c. Describe the work procedures, materials, and tools the contractor proposes to use for each Masonry Treatment Requirement (MTR) specified.
- d. Describe the sequence of each MTR.
- e. Describe how each MTR sequence and the overall construction schedule changes with weather variations and how completed work will be protected.
- f. Describe the methods for surveying original layout and collecting datum points and plumb lines for rebuilding masonry.
- g. Describe the methods for shoring and providing a safe working environment.
- h. Describe the methods for select deconstruction of individual masonry units and tools/methods for cleaning the masonry for reuse.
- i. Describe the method and approach to mortar joint removal.
- j. Describe the method and approach for assuring repair material compatibility with original materials.

- k. Describe the method and approach to cleaning mortar, coating, smears and old patching materials from the masonry surfaces.
- 1. Describe, in detail, the procedures relating to techniques and tools proposed for masonry matching.
- m. Describe the complete masonry removal and matching procedures; include equipment, approach, length of time the masonry will be out of the wall, documentation on mapping the location, and where (on-site or in shop) the masonry units will be repaired.
- n. Describe the procedure for matching of different colors at different locations.
- o. Describe the procedure for mixing and matching of repair materials.
- p. Describe the methods and system by which the use of reclaimed masonry units can be utilized.
- q. Describe the methods for setting masonry back into its original position and maintaining the original bond patterns and joint width.
- r. Describe the methods of transition points where replacement/preservation work will meet the original historic work.

1.5.2 Qualifications

- 1.5.2.1 Historic Masonry Consultant
 - a. Secure the services of a historic masonry consultant with a minimum of 10 years experience applying NPS Hist Prop as they relate to the work in this section.
 - b. Submit a resume that describes five relevant projects within that period and include how NPS Hist Prop was applied to the work of similar scope and scale and what jurisdiction or agency was involved in approving the work..
 - c. The consultant's services include:
 - (1) Investigating the condition of the masonr materials and mortar.
 - (2) Arranging for material analysis in the laboratory
 - (3) Recommending appropriate cleaning methods and materials
 - (4) Recommending restoration options.
 - (5) Providing project specific specifications.
 - (6) Providing an on-site training program.
 - (7) Providing quality control services during construction.
 - (8) Recommending appropriate repair and restoration materials.

1.5.2.2 Masonry Firm

- a. The firm performing the masonry work shall have a minimum of five years experience on relevant projects.
- b. The firm shall have completed work similar in material, design, and extent to that indicated for this Project and shall demonstrate a record of successful in-service performance.
- c. Proven implementation of NPS Hist Prop and related Preservation Briefs are required.
- d. Submit a resume that describes the required experience.

1.5.2.3 Field Supervisor

Retain an experienced full-time supervisor on the project site at all times when masonry restoration is in progress. A single individual shall be responsible for supervising the historic masonry restoration work throughout the duration of the project.

Submit a resume that describes the required experience.

1.5.2.4 Masonry Applicator

- a. Employ craftspeople who are experienced with and specialize in restoration work of the types they will be performing.
- b. All masonry restoration treatments must be performed by a craftsperson that is familiar with historic masonry construction and has worked on historic masonry projects for at least five years.
- c. Only skilled technicians who are familiar and experienced with the materials and methods specified may be used.
- d. Submit resumes for all historic masonry applicators, demonstrating the required experience.

1.5.3 Mortar Analyst

Laboratory mortar analysis equipment should be operated by and results analyzed by trained personnel experienced with analysis of historic masonry mortar.

1.5.4 Documentation

Submit digital photographic documentation of the all phases of masonry restoration, including prior to the start of restoration work.

Provide thorough photo documentation of the project and project details and targeted areas.

1.5.5 Cleaning and Restoration Methods

1.5.5.1 General Procedure

a. Submit the cleaning and restoration methods, and materials selected for a specific structure for approval before work starts.

- b. Take into account the total construction system of the building to be worked upon, including different masonry and mortar materials, as well as non-masonry elements which may be affected by the work.
- c. Utilize mockups to identify the appropriate cleaning and restoration treatment and materials and set the standard for each project task.
- d. Demonstrate the correct execution of the approved cleaning and restoration methods and materials during the on-site workmanship training program within the framework of ASTM E2659.
- 1.5.5.2 Cleaning Products and Procedures
 - a. General Cleaning Requirements
 - (1) Establish cleaning products and procedures during the mockup process.
 - (2) Select the least aggressive method used to achieve the desired level of cleanliness.
 - (3) Where chemical products are selected for cleaning, use them in accordance with the manufacturer's instructions.
 - b. Cleaning Mock-Ups
 - Demonstrate the materials, equipment, and methods to be used in cleaning in a test section approximately 3 feet by 3 feet.
 - (2) Locate test patches in inconspicuous areas of the building. The areas tested are subject to approval by the Contracting Officer. The areas tested shall exhibit soiling characteristics representative of those larger areas to be cleaned.
 - (3) Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained.
 - (4) Conduct tests on areas to be stripped of paint.
 - (5) Allow tested areas to dry before a determination is made on the effectiveness of a particular treatment.
- 1.5.6 Masonry Restoration Products and Procedures
 - a. General Restoration Requirements
 - (1) Do not use masonry or mortar in the work until the mock-ups and the represented material and workmanship have been submitted and approved.
 - (2) Demonstrate the methods and quality of workmanship to be performed in each masonry treatment requirement (MTR). Provide a mock-up for each MTR indicated.
 - b. General Restoration Mock-Up Requirements
 - Throughout restoration, retain approved mock-up panels in undisturbed condition, suitably marked, as a standard for judging completed work.
- (2) Review manufacturer's product data sheets to determine suitability of each product for each surface.
- (3) Apply products using manufacturer-approved application methods, determining actual requirements for application..
- (4) Obtain approval as to the preservation treatment approach, design, and workmanship to include, but not limited to the verification of all material applications and finishes as specified to the requirements of color, texture, profiles, and finishes before proceeding with work.
- (5) Mock-ups: May be performed on inconspicuous sections of actual construction under the same weather conditions expected the remainder of the work.
 - (a) Location and number as directed, but no more than three.

(b) Size: 3 feet by 3 feet or as appropriate for the repair specified.

(c) Repair unacceptable work.

- c. Restoration Mock-Ups
 - (1) Repointing: Repoint mortar joints, minimum acceptable mock up dimensions: twelve feet in length - 2/3 horizontal joints and 1/3 vertical joints. Demonstrate method for cutting out mortar joints, preparing wall for repointing, mixing mortar, installing mortar and curing the mortar. Prepare and place repointing mortar in accordance with NPS TPS Brief 2 and in compliance with NPS Hist Prop.
 - (2) Retooling Stone Masonry In situ: Demonstrate treatment technique and methods to retool three deteriorated stone faces in situ in all known historic profile textures identified.
 - (3) Masonry Removal and Replacement: Fully remove masonry and replace to specified dimensions and texture. Select size of masonry units representing typical conditions. Return one masonry unit to same location, set to surrounding profile joint width and bond pattern. Set masonry unit using specified mortar. Confirm with Contracting Officer's Representative that the replacement masonry units meet specification requirements for matching and that sufficient quantity required for the work have been identified. Leave one stone dry-set into opening set on wood shims for evaluation and approval of preparation conditions.
 - (4) Repair Material

(a) Patching: Apply repair material on at least two masonry units for repair. Include one masonry unit on which to demonstrate proficiency in removing previous patching material and repairing with new substitute repair material. Include the removal of metal anchors at two locations and fill in the holes with repair material on the second masonry unit (where applicable).

(b) Dutchman: Undertake dutchman repairs in two locations,

including one that is only cut and prepared for application. Demonstrate the quality of the stone insert, as well as the workmanship and techniques to be performed in the dutchman repairs. Do not proceed with other dutchman repairs until the technique has been approved.

- (5) Crack Repair: Repair one crack, 2 feet in length, using mortar. Repair one crack, 2 feet in length, using dispersed hydrated lime injection technique with appropriate repair material.
- (6) Surface Treatments: Install a minimum 1.5 square meter 16 square foot mockup for each surface treatment on each substrate to be treated. For stucco, demonstrate the means for installing each coat; including mechanical support systems such as wood or metal lath. For water repellents and/or consolidants, demonstrate the equipment and installation procedure. Allow 48 hours for limewash applications to dry to their final color and appearance.
- (7) New Masonry Elements: Install new components in a manner demonstrating their final installation on the structure.
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - a. Furnish cement in suitable bags used for packaging cements.
 - b. Provide packages with labeling that clearly defines contents, manufacturer, and batch identification.
 - c. Provide detergents, masonry cleaners, paint removers, solvents, epoxies and other chemicals used for masonry cleaning in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer.
 - d. Store materials in weathertight structures which will protect all materials from moisture and contaminants.
 - e. Store accessories to avoid contamination and deterioration.
 - f. Do not use admixtures which have been in storage onsite for six months or longer, or which have been subjected to freezing, unless retested and proven to meet the specified requirements.
- 1.7 PROJECT/SITE CONDITIONS
- 1.7.1 Environmental Requirements
 - a. Do not place materials when weather conditions adversely affect the quality of the finished product.
 - b. Do not place masonry or mortar when the air or surface temperature is below 40 degrees F in the shade and will remain so for at least 48 hours after completion of the work. Heated enclosures may be used to overcome ambient weather restrictions, where such enclosures are feasible.
 - c. Do not place masonry or mortar when air or surface temperature is above 90 degrees F with a wind speed above8 miles per hour and will remain

so for at least 48 hours after completion of the work.

- d. Do not place masonry or mortar when air or surface temperature is above 100 degrees F with or without wind and will remain so for at least 48 ours after completion of the work.
- e. Do not product or place materials during periods of rain or other precipitation. Stop material placements, and protect all in-place material from exposure, during periods of rain or other precipitation.
- f. Clean masonry surfaces when air temperatures are above 40 degrees F and will remain so until masonry has dried out, but for not less than 7 days after completion of the work.
- g. Do not perform work in wind conditions that may blow materials onto surfaces not intended to be treated.
- 1.7.2 Masonry Installation Requirements
 - a. Phase work during hot weather by performing work on the shady side(s) of the building during daylight hours and on the daylight side(s) of the building during cooler evening hours to prevent premature evaporation of the water from the mortar.
 - b. Do not use frozen materials or materials mixed or coated with ice or frost. Do not apply materials to frozen surfaces; allow complete thawing prior to installation.
 - c. Do not lower the freezing point of mortar by the use of admixtures or anti-freeze agents. Do not add chlorides or admixtures containing greater than 0.2 percent chlorides to the mortar, per TMS MSJC.
 - d. Prevent mortar from staining the face of the masonry or other exposed surfaces. Immediately remove mortar that comes in contact with such surfaces. Cover partially completed work when work is not in progress. Protect sills, ledges and projections from mortar droppings. Building damage resulting from work of this Section is the Contractor's responsibility. Restore damaged areas to the satisfaction of the Owner at no expense to the Owner. Do not apply products under conditions outside product manufacturer's requirements.

1.8 WARRANTY

1.8.1 Cleaning Warranty

Warrant cleaning procedures for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to: discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

1.8.2 Repair Warranty

Warrant repair procedures, including repointing, for a period of two years against: discoloration or mismatch of new mortar to adjacent original historic mortar, discoloration or damage to masonry from improper mortar clean-up, loss of bond between masonry and mortar, fracturing of masonry edges from improper mortar joint preparation procedures or improper mortar formulation, and occurrence of efflorescence from improper repair

procedures.

- PART 2 PRODUCTS
- 2.1 CLEANING MATERIALS
- 2.1.1 General Requirements

Selection of appropriate cleaning products requires a clear understanding of the masonry materials to be cleaned, a rationale for the cleaning, and an understanding of the anticipated level of cleanliness expected from the cleaning program. Overly aggressive cleaning methods and materials can cause subtle, long-term damage to masonry units. Use products that have a minimum 5 year performance record on relevant projects. Select the products predicated on long-term negative effects to the masonry rather than current level of cleanliness of the comparable structure.

2.1.2 Paint Removers

- a. Provide chemical paint removers that are water soluble, low toxicity products, effective for removal of paint on masonry without altering, damaging, or discoloring the masonry surface.
- b. Provide commercially available poulticing materials designed to adhere to and peel off paint without damaging the underlying masonry or project specific mixtures that include absorbent materials and cleaning solutions which can be demonstrated to do no harm to the masonry.

2.1.3 Chemical Cleaners

- a. Provide commercially available products that have a proven record of cleaning masonry without altering, damaging or discoloring the masonry units, mortar or surrounding materials.
- b. Provide the associated pre and post treatment material to neutralize the long term effects of the chemicals.

2.1.4 Biocides

Provide commercially available biocides with accompanying product literature containing information on the product as well as the expected service life of the material and any detrimental effects it may have on the masonry or mortar.

2.1.5 Liquid Strippable Masking Agent

Provide manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from the damaging effect of acidic and alkaline masonry cleaners.

2.1.6 Cleaning Implements

Furnish brushes that contain natural or nylon fiber bristles only. Do not use metallic wire brushes. Scrapers and application paddles shall be made of wood with rounded edges. Metallic tools are not permitted.

2.1.7 Water

Obtain potable water from a local source.

- 2.2 REPAIR MATERIALS
- 2.2.1 General

Use repair materials of one type and from one source, when used in repair treatments that will have surfaces exposed in the finished structure.

2.2.2 Mortar and Stucco

2.2.2.1 Testing and Matching

- a. Take test specimens of existing mortar and stucco from a sound and intact representative portion of the structure, at locations indicated by the Contracting Officer's Representative and assess in accordance with ASTM C1713 and ASTM C1324.
- b. Subject a part of the historic mortar sample to petrographic examination and differential thermal analysis, or X-ray diffraction, or analytical chemistry to determine the binder components.
- c. Aggregate Analysis
 - (1) Separate aggregate of the mortar sample from the binder by taking the crushed mortar sample and either gently blowing away the fine binder material, placing the crushed sample in a centrifuge, or chemically separating the aggregate from the binder.
 - (2) Rinse the separated aggregate clean with water and dry. Examine the aggregate with a magnifying glass, and record the component materials as to range of materials, sizes, colors, as well as the presence of other materials.
 - (3) Perform sand analysis using a sieve analysis of the aggregate as part of the ASTM C1324 process.
- d. Match the replacement mortar and stucco to the original existing material in color, texture and tooling.

2.2.2. Replacement Mortar and Stucco

Provide replacement mortar and stucco that will:

- a. Coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity.
- b. Have greater vapor permeability and be softer (measured in compressive strength) than the masonry units.
 - (1) Measure water vapor transmission in accordance with ASTM E96/E96M.
 - (2) Prepare ASTM E96/E96M water vapor transmission specimens with thickness similar to that expected in service, or a maximum of 1/2 inch, whichever is thinner.

- c. Be as vapor permeable, and as soft, or softer, (measured in compressive strength) than the existing historic mortar or stucco.
- 2.2.2.3 Binder Content

Provide binder type or mixture of mortar (and stucco) with a cement, lime, or combination thereof consistent with the original existing mortar (and stucco) content in order to provide uniform durability, weathering characteristics, and the same, or better, life-cycle performance expectations.

2.2.2.4 Admixtures

Do not use admixtures in the mortar or stucco unless specifically approved in writing by the Contracting Officer.

- 2.2.3 Crack Injection
 - a. Comply with the dispersed hydrated lime manufacturer's written instructions.
 - b. Inject cracks that are no greater than 1/8 inch in width and masonry is soundly bonded but cracked.
 - c. Inject the full length of the cracks unless specifically instructed otherwise.
- 2.2.4 Replacement Masonry Materials

2.2.4.1 Clay Brick

- a. Provide replacement brick matching color, shape, size, texture, appearance, and thermal expansion properties of the existing historic brick.
- b. Test brick in comparison to the original existing historic brick using ASTM C67.
- c. Do not use reclaimed brick unless approved by Contracting Officer.
- d. Provide brick meeting the requirements of ASTM C216 Grade SW, including a rating of "not effloresced", unless otherwise specified.

2.2.4.2 Stone

- a. Provide replacement stone matching type, color, shape, size, texture, finish-profile, and compressive strength of the existing historic stone units.
- b. Test replacement stone in comparison to the existing historic stone using ASTM C170/C170M.

2.2.4.3 Terra Cotta

- a. Provide replacement terra cotta matching color, shape, size, texture and finish-profile of the existing historic terra cotta units.
- b. Test replacement terra cotta in comparison to the existing historic terra cotta using ASTM C34.

2.2.4.4 Architectural Precast Stone

- a. Provide replacement architectural precast stone matching color, shape, size, texture and finish-profile of the existing historic architectural precast stone units.
- b. Test replacement architectural precast stone in comparison to the existing historic architectural precast stone using ASTM C1364.
- 2.2.5 Surface Treatments
- 2.2.5.1 General

Provide commercially available coatings with water vapor permeabillity of 0.98 or greater, as measured in accordance with ASTM E96/E96M, including silanes and siloxanes.

2.2.5.2 Consolidants

Provide commercially available consolidants designed to strengthen loose or deteriorated stone without damaging intact stone or reducing water vapor permeability below 0.98, as measured in accordance with ASTM E96/E96M.

2.2.5.3 Water Repellents

Provide commercially available water repellents designed to preclude water droplet entry into the masonry walls without reducing water vapor permeability below 0.98. as measured in accordance with ASTM E96/E96M.

- 2.2.6 Miscellaneous Materials
- 2.2.6.1 Cementitious Grout

Use cementitious grout, recommended by the manufacturer for the application, to bond steel anchors to masonry.

- 2.2.6.2 Metal Attachments
 - a. Provide threaded or deformed stainless steel anchors for spall repairs, size as indicated.
 - b. Provide other plates, angles, anchors, and embedments conforming to ASTM A36/A36M, prime painted with inorganic zinc primer. Loose laid steel angles for brick lintels shall be hot-dipped galvanized.

2.2.6.3 Through-Wall Flashing, Weeps and Other Flashing

- a. Copper Coated Flashing: Provide 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, asphalt impregnated kraft paper or polyethylene sheets. Provide product data for all Flashings and accessories prior to start of work.
- b. Weep Ventilators: Provide weep ventilators that are prefabricated from stainless steel or plastic. Provide inserts with grill or louver-type openings designed to allow the passage of moisture from cavities and to prevent the entrance of insects, and wit a rectangular closure strip to preven mortar droppings from clogging the opening. Provide ventilators with compressible flanges to fit in a standard 3/8 inch

wide mortar joint and with height equal to the nominal height of the unit.

- c. Metal Drip Edge: Provide stainless steel drip edge, 15-mil thick, hemmed edges, with down-turned drip at the outside edge and upturned dam at the inside edge for use with membrane flashings.
- d. Submittals: Provide product data for all flashing and associated accessories prior to start of work. Provide shop drawings for all flashing and accessories for each condition requiring replacement as indicated in the drawings.

2.3 EQUIPMENT

2.3.1 Cleaning Equipment

Provide cleaning equipment that does not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

2.3.1.1 Sandblasting

Use of sandblasting equipment is not allowed for cleaning masonry surfaces.

2.3.1.2 Water Blasting

- a. Provide water blasting equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment.
- b. Do not operate the equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints. Operate the equipment at a discharge capacity of 55 to 400 psi and 2.5 to 3 gpm for general surface cleaning operations.
- c. Provide water tank and auxiliary re-supply equipment of sufficient capacity to permit continuous operations.
- d. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.1.3 Alternative Blasting Equipment

- a. Alternative blasting methods require equipment designed to discharge sponges, walnut shells, ice, soda and other friable materials.
- b. Operate equipment in accordance with manufacturer's recommendations and maintain in good working order.
- c. Do not operate equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints.
- d. Determine discharge capacity on a case by case basis during the mockup test panel demonstration and approval process.
- e. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.2 Spray Equipment

- a. Provide spray equipment for chemical cleaners with low-pressure tanks or chemical pumps suitable for chemical cleaner indicated, and equipped with stainless steel, cone-shaped spray-tip.
- b. Disperse water through a fan-shaped spray tip at an angle of not less than 15 degrees.
- c. Deliver water at a pressure not greater than 400 psi and at a volume between 2.5 and 3 gpm.
- d. Deliver heated water at flow rates indicated maintaining between 140 and 180 degrees F.
- 2.3.3 Drilling Equipment
 - a. Use standard small, powered, handheld masonry drills, commonly used for drilling small holes in concrete and masonry to drill holes in masonry for patch anchors and other applications.
 - b. Use drills in rotary mode only. Do not use impact type drills.
- 2.3.4 Compressed Air Supplies
 - a. Use compressed air equipment that delivers clean, oil and moisture free compressed air at the surface to be cleaned. Use a minimum of two in-line air filters to remove oil and moisture from the air supply.
 - b. Test the compressed air supply during each shift for the presence of oil and moisture.
- 2.3.5 Material Handling and Associated Equipment
- 2.3.5.1 Mixing, Transporting, and Placing Job Materials
 - a. Provide equipment used for mixing, transporting, placing, and confining masonry and mortar placements capable of satisfactorily mixing material and supporting uninterrupted placement operations.
 - b. Provide equipment used for mixing, conveying, and placing of materials that is clean, free of old materials and contaminants, and in conformance with material manufacturer's recommendations.
- 2.3.5.2 Associated Equipment

Provide associated equipment, such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools, as required to ensure a continuous supply of material and operation control.

- 2.4 Mortar Mix
- 2.4.1 General
 - a. Proportion materials appropriately with regard to the effect of moisture content on the individual components (cement, sand and lime).
 - b. Batch materials using volumetric measurement devices and consistently consolidate the material in these devices to ensure the uniformity of

the mortar. Do not batch by shovel counts.

2.4.2 Batching

- a. Utilize a calibrated measuring device for batching Portland cement.
- b. Utilize a calibrated measuring device for batching hydrated lime or lime putty.
- c. Utilize a calibrated measuring device for batching the sand.
- 2.4.3 Cement and Lime Proportions
 - a. Fill the measuring device with portland cement, hydrated lime or lime putty.
 - b. Briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush.
 - c. For dry hydrate lime, fill the measuring device using a minimum of 3 lifts, strike the bottom of the measuring device against the ground a minimum of ten times for each lift and then strike the top flush. Mix dry hydrate lime to a wet paste that is 40 to 42 percent solid.
 - d. For lime putty briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush. No additional lime is required when measuring from putty.

2.4.4 Sand Proportions

- a. Proportion sand when the sand is in saturated surface dry (SSD), loose damp condition.
- b. Proportion the sand by filling a measuring device using a minimum of 3 lifts, striking the sides a minimum of ten times, and then striking the top flush.
- PART 3 EXECUTION

3.1 EXAMINATION

- a. Undertake masonry renovation only after complete evaluation and analysis of the areas to be repaired are completed, including sampling and testing of the existing mortar to determine its composition and qualities. Do not start repair work until conditions that have caused masonry deterioration have been identified and corrected.
- b. Use the gentlest means to perform the work and take the greatest of care to ensure that the historic materials are not damaged in the process of the work, as established by mock-ups and testing.
- c. In addition to requirements in this Section, comply with NPS Hist Prop.
- 3.1.1 Field (In Situ) Mortar Examination
 - a. Detect cracks, degradation and de-bonding from the surrounding masonry.
 - b. Determine previous surface coating treatments that may be contributing to the current conditions.

- c. Compare the bedding mortar with the pointing mortar and determine the cross-sectional characteristics of the wall.
- d. Determine the level of moisture movement in the in situ mortar, and if the mortar or masonry units are handling the brunt of the water movement through the wall.
- e. Evaluate in situ mortar joint shear strength in accordance with ASTM C1531.
- 3.1.2 Taking and Preparation of Samples
 - a. Take and analyze samples of unweathered original historic mortar and different types of mortar in the structure in order to match the new mortar to be used for repointing.
 - b. Remove three or four samples of each type of mortar to be matched with a hand chisel from several locations on the building. Mortar samples to be intact pieces with a minimum size of 1 ounce.
 - c. Set aside the largest sample for comparison with the repointing mortar.
 - d. Place the remaining samples in labeled, sealed sample bags for transport to the laboratory for evaluation per Part 2 of this Specification.

3.2 PREPARATION

3.2.1 Protection

- a. Protect persons, motor vehicles, adjacent surfaces, surrounding buildings, equipment, and landscape materials from chemicals used and runoff from cleaning and paint removal operations.
- b. Erect temporary protection covers, which will remain in operation during the course of the work, over pedestrian walkways and at personnel and vehicular points of entrance and exit.
- c. Protect the interior of buildings from the weather, cleaning, and repair operations at all times.
- d. Do not expose workers to chemical substances in excess of the limits established by ACGIH 0100. Comply with more stringent regulations where applicable.

3.2.2 Surface Preparation

- a. Do not proceed with cleaning until mock-ups have been approved.
- b. Do not proceed with repointing or stucco until existing mortar and stucco have been analyzed and suitable repair materials have been determined.
- c. Do not proceed with restoration work until the cause of observed distresses have been identified and corrected.
- d. Do not proceed with surface treatments until all other restoration work has been completed.

- 3.2.3 Equipment and Techniques Demonstration
 - a. Demonstrate equipment and techniques of operation in an approved location.
 - b. Assemble dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, at the work site with sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required.
 - c. Maintain the equipment in good working condition throughout the project.
- 3.3 MASONRY CLEANING
- 3.3.1 General
 - a. Exercise caution against over-cleaning of surfaces, which may be detrimental, and which may remove desirable historic surface details or patinas. For example, if cleaning reveals unexpected joint painting or historic signage; suspend the cleaning action, protect the exposed area and notify the Contracting Officer.
 - b. Do not damage or mar historic materials in the process of cleaning.
 - c. Perform cleaning per NPS TPS Brief 1.
 - d. Protect open joints to prevent water and cleaner intrusion into the interior of the structure.
 - e. Protect non-masonry materials and severely deteriorated masonry by approved methods prior to initiation of cleaning operations.
 - Remove all organic and inorganic contaminants from the surface and pores of the substrate, without causing any short or long-term negative consequences.
 - g. Clean surfaces evenly with no evidence of streaking or bleaching.
 - h. Do not affect the density, porosity, or color of the existing masonry or mortar.
 - i. Maintain a neutral pH on surface of cleaned masonry units.
 - j. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results.
 - k. Proceed with cleaning in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.
 - Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry.
 - m. Use the following sequence of methods to determine the least aggressive, effective cleaning method:
 - (1) Water with non-metallic brushes (cold water).

- (2) Water with mild soap (non-ionic detergent)
- (3) Water with stronger soap
- (4) Water with stronger soap plus ammonia
- (5) Water with stronger soap plus vinegar (but not on calcareous masonry)
- (6) Stronger chemical cleaners, only when above methods are determined to be ineffective by the Contracting Officer

3.3.2 Chemical Cleaners

- a. Do not use chemical cleaners without approval from the Contracting Officer.
- b. Do not use acidic chemical cleaners on limestone, marble, concrete and other calcareous (calcium containing) masonry materials. If chemical cleaners are used on such materials, use alkaline based cleaners with neutralizing afterwashes.
- 3.3.3 Paint Removal
 - a. Prior to removal, test existing paint for lead in accordance with 40 CFR 745.
 - b. Clean areas where paint is to be removed with water and detergent solution to remove surface dirt. Rinse and allow to dry.
 - c. Remove paint and other coatings from masonry surfaces in areas indicated prior to general cleaning.
 - d. Do not damage or mar masonry in the process of paint removal.
 - e. Apply chemical paint removers in accordance with manufacturer's instructions.
 - f. Protect surrounding painted surfaces from exposure to chemical paint removers to avoid damage.
 - g. Remove paint containing lead in accordance with 40 CFR 745.
- 3.3.4 Water Cleaning

3.3.4.1 Pressure Spraying

- a. Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment.
- b. Unless otherwise indicated, wash the surface with clean, low pressure water (pressure of less than 55 psi and 2.5 to 3 gpm discharge) and hold spray nozzle not less than 12 inches from surface of masonry.
- c. Apply water side to side and top to bottom in overlapping bands to produce uniform coverage.

3.3.4.2 Hand Scrubbing

- a. Scrub surfaces to be cleaned to remove surface contaminants.
- b. Pre-wet surfaces and use hand-held natural bristle or nylon brushes.

c. Do not use wire brushes.

3.3.4.3 Rinsing

- a. Rinse scrubbed surfaces clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working from top to bottom of each treated area.
- b. Remove all traces of contaminants and cleaning solutions.
- 3.3.5 Chemical Cleaning
- 3.3.5.1 General
 - a. Chemical cleaning is the use of any product in addition to water, including detergents, ammonia, vinegar, and bleach.
 - b. Use gentlest means possible to achieve the desired result as determined by test patches.
 - c. Proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.
 - d. Provide uniform coverage of all surfaces, including corners, moldings, interstices and produce an even effect without streaking or damage to masonry.
 - e. Do not apply chemical cleaners to the same masonry surfaces more than twice.
- 3.3.5.2 Surface Prewetting
 - a. Wet masonry surfaces to be cleaned with chemical cleaners with water using a low pressure spray before application of any cleaner.
 - b. Prewet walls working from top to bottom, except work bottom to top on one-story walls.
 - c. Do not prewet masonry surface prior to applying biocides.

3.3.5.3 Acidic Chemical Cleaning

- a. Apply acidic chemical cleaners according to manufacturer's instructions.
- b. Do not apply acidic chemical cleaners to masonry with high calcium content (e.g. marble, limestone.
- c. Apply acidic cleaners to masonry surfaces by low pressure spray 50 psi max., roller, or brush.
- d. Leave cleaner on on masonry surface for the time period recommended by the manufacturer.
- e. Employ manual scrubbing by brushes as indicated by test patches for the specific location.
- f. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaner.

3.3.5.4 Alkaline Chemical Cleaning

3.3.5.4.1 Prewash Phase

- a. Apply alkaline chemical cleaners to masonry surfaces according to manufacturer's instructions, by low pressure spray 50 psi max., roller, or brush.
- b. Leave cleaner on masonry surface for the time period recommended by the manufacturer.
- c. Employ manual scrubbing by brushes as indicated by test patches for the specific location.
- d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water.

3.3.5.4.2 Afterwash Phase

- a. Immediately after rinsing of alkaline cleaned surfaces, apply a neutralizing afterwash to the cleaned masonry areas.
- b. Apply neutralizing afterwash according to manufacturer's instructions, by low pressure spray 50 psi max., roller, or brush.
- c. Leave afterwash on masonry surface for the time period recommended by manufacturer.
- d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaners.
- 3.3.5.5 Rinsing and pH Testing
 - a. Determine the pH of masonry surfaces that have been chemically cleaned using pH monitoring pencils or papers.
 - B. Rinse chemically cleaned masonry, using a low pressure spray, until a neutral pH (7) reading is obtained from the masonry unit surface.
- 3.4 MASONRY REPAIR

3.4.1 General

- a. Match repaired surfaces with adjacent existing surfaces in all respects.
- b. Demonstrate the materials, methods and equipment proposed for use in the repair work in mock-ups, as specified in Part 2.
- c. Use products in accordance with the manufacturer's instructions.
- d. Proceed with masonry repair only after the cause of deterioration has been corrected.
- e. Assist Historic Masonry Consultant with performing field investigation to determine the causes and extent of degradation. Utilize the following techniques.
 - (1) Employ a field microscope to closely assess the conditions at the surface of the mortar and masonry units. Detect cracks and assess

for degradation and debonding from the surrounding masonry. Detect previous surface coating treatments on the mortar and masonry that may be contributing to the current conditions.

- (2) Employ a boroscope to examine mortar deeper in the joint. Compare the bedding mortar with the pointing mortar and ascertain the cross-sectional characteristics of the wall.
- (3) Employ moisture meters to determine the level of moisture in the mortar and masonry, and if the mortar or masonry units are handling the brunt of the water movement through the wall. Infrared thermography, employed by a trained investigator, can provide additional information on the moisture conditions.
- (4) Employ RILEM tubes using the method of RILEM II.4 or water penetration testing in accordance with ASTM C1601 to determine the rate of water uptake into the masonry.
- (5) To access the physical characteristics of hard mortar, use a spring loaded or pendulum impact device to determine surface hardness as an indicator of relative compressive strength. For evaluating softer mortars, mortar integrity deeper in the wall, and the condition of the masonry units, use a drill resistance tool by an experienced consultant.
- (6) Utilize technologies such as ground penetrating radar or metal detection equipment to map metal reinforcement and embedments in the wall.
- (7) Use flat jack or jacks and rams to gather information on in situ compressive stress (ASTM C1196, masonry compressive response ASTM C1197, and mortar joint shear strength ASTM C1531.

3.4.2 Repointing Masonry

Repoint masonry in accordance with NPS TPS Brief 2, using ASTM E2260 as a reference guide..

3.4.2.1 Wall Preparation

- a. Remove old caulking, grout, or non-original mortar from previously repaired joints to a minimum depth of 2.5 times the width of the joint or 1" minimum, whichever is greater. Cut all joints (unless otherwise noted) back to sound, solid, back up material. Leave a clean, square face at the back of the joint to provide for maximum contact of repointing mortar.
- b. Shallow or feather edging is not permitted. Remove loose particles from joints. Clean joints, followed by blowing with filtered, dry, compressed air or vacuum.
- c. Cut out existing horizontal mortar joints (bed joints) that are filled with a hard Portland mortar using a diamond blade that is narrower than the joint width. Cut out the middle one-third of the mortar joint using a rotary power saw. Remove the remaining mortar from the masonry joints by hand using masonry chisels or pneumatic carving tools.
- d. Do not use rotary power saws to cut out vertical joints (head joints) . Remove all vertical head joints by hand using a pneumatic carving tool,

or hammer and chisel.

- e. Remove existing historic lime-based mortar using only small-headed chisels that are no wider than half the width of the existing masonry joints. Pneumatic air carving chisels are permitted as are specially designed mortar removal reciprocating tools (i.e. Arbortech Saw).
- f. Do not widen the existing masonry joints. Do not chip or spall the surrounding masonry edges in the process of mortar removal. Damage to surrounding masonry units resulting from rotary blade over running is not permitted. Damages to adjacent materials exceeding 1/8 inch in size are the responsibility of the contractor and must be repaired by removal and replacement of damaged materials.

3.4.2.2 Presoaking Masonry / Mortar Consistency / Lifts

- a. Use the same mortar as the repointing mortar for setting the replacement masonry.
- b. Soak exposed surfaces of historic masonry adjacent to joint with water prior to repointing.
- c. Allow time for excess water to run off and evaporate prior to repointing. Joint surfaces shall be damp but free from standing water.
- d. Maintain a water sprayer on site at all times during the repointing process.
- e. The mortar material shall resemble the consistency of brown sugar during installation. This drier consistency enables the material to be tightly packed into the joint, allows for cleaner work, and prevents shrinkage cracks as the mortar cures.
- f. Allow mixed repointing mortar to stand for not less than one-half hour and not more than one and one-half hours for pre-hydration to reduce post-curing shrinkage. After this time, water can be added to small batches by hand to bring the mortar to a stiff yet workable consistency. Use repointing mortar within two and one-half hours after initial mixing and within one hour after adding water to bring the mortar to a working consistency. Retempering of the mortar to replace evaporated water is permitted within these time frames.
- g. Point joints in layers or "lifts" where the joints are deeper than 1-1/4 inch. Apply in 1/4" lifts, allowing each lift to be thumbprint hard before applying the next lift.
- 3.4.2.3 Compression / Joint Finish / Curing
 - a. Compress each layer thoroughly.
 - b. When mortar is thumbprint hard at the surface of the wall, finish the joints to match the original historic joint profile.
 - c. For Type L mortar:
 - Allow water evaporation from the freshly repointed walls in order to initiate the carbonation process in high lime content mortars. The carbonation of lime mortar initially requires wet-and-dry

cycles, which can be created by water misting the joints after the mortar application when dry weather conditions prevail. Finish the joint profile before these cycles are started.

- (2) Depending on the environmental conditions (temperature and humidity), carry out water misting until a full nine alternating wet-and-dry cycles are completed.
- (3) Adjust curing methods to ensure that the repointing mortar is damp without eroding the surface of the mortar.

3.4.2.4 Protection

- a. Keep the mortar from drying out too quickly or from becoming too wet.
- b. Protect mortar from direct sun and high winds for the first 72 hours after installation or from driving rain for the first 24 hours, using plastic sheeting if necessary. Do not create a greenhouse effect by sealing off air movement in an attempt to protect the wall with plastic. Allow for air circulation to facilitate the carbonation process.
- 3.4.3 Retooling Stone Masonry In situ
 - a. Scale off all loose pieces of original stone from masonry intended to remain in place, including surface material in powder or granular form and detachments of planer elements, spalls and chips.
 - b. Assess all stone on building by sounding (tapping with a small hammer) or by using impact echo (for massive stones), surface penetrating radar, or infrared thermography in order to distinguish fully intact stone from those in which delamination may be hidden or pieces of unstable material may not be immediately visible.
 - c. Remove and replace stone units that are designated for retooling in situ, but develop a solid stone substrate that is no longer in plane or plumb with the surrounding stone masonry surfaces after chiseling is complete.
- 3.4.4 Masonry Removal and Replacement
 - a. Before removing any deteriorated masonry units, establish bonding patterns, levels and coursings. Remove masonry that has deteriorated or is damaged beyond repair, as determined through investigation and evaluation. Carefully demolish or remove entire units from joint to joint, without damaging surrounding units in a manner that permits replacement with full-size units. Support and protect remaining masonry work that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition. Notify Contracting Officer of unforeseen detrimental conditions including voids, cracks, bulges, and loose masonry units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items. Remove as many whole masonry units as possible without damage.
 - b. Remove mortar, loose particles, and soil from masonry by cleaning with hand chisels, non-metallic brushes, and water.
 - c. Remove sealants by cutting close to masonry units with utility knife

and cleaning with solvents. Clean surrounding masonry areas by removing mortar, dust, and loose particles in preparation for replacement.

- d. Replace removed masonry with masonry units removed from inconspicuous areas of the building, where possible, or with new masonry units matching the existing units. Butter vertical joints for full width before setting and set units in full bed of mortar, unless otherwise indicated. Remove mortar used for laying/setting masonry units before mortar sets to the repointing depth of the surrounding area. Repoint new mortar joints in repaired area to comply with requirements for repointing at existing masonry units.
- e. If a few isolated masonry units are to be replaced, remove each without disturbing the surrounding masonry. Remove deteriorated masonry units and mortar requiring replacement by hand chiseling. Do not damage adjoining masonry units during the removal of deteriorated units and mortar.
- f. Test the new element for fitting into its space without mortar. Use wedges made from non-expanding, non-corrosive material such as plastic to support and align the new unit, cover them with at least 1-1/2 inches of mortar when pointing is complete.
- g. Cover the four sides of the space with sufficient mortar to ensure that there will be no air spaces when the new unit is set. Fill the back of the space with mortar only if it matches existing construction.
- h. Line up and set the new unit by tapping it into place with a wooden or rubber mallet. Align the face of new unit with that of existing masonry.
- i. Repoint joints to match the rest of the wall after new units have been properly installed and adjusted.
- j. Clean replacement areas with a non-metallic brush and water to remove excess mortar.
- 3.4.5 Material Repair

Repair or replace original historic masonry materials only if surfaces are extensively deteriorated (surface missing to a depth of 4 inches or more) or are threatening the safety of the structure or individuals. If additional damage is found, notify the Contracting Officer. Repairs and replacements shall match the materials, colors, and finish of the existing historic masonry as closely as possible.

- 3.4.5.1 Selective Demolition
 - a. Remove unsound, weak, or damaged masonry and mortar in areas as indicated.
 - b. Remove loose particles, laitance, spalling, cracked, or debonded masonry and mortar and foreign materials with hand tools unless otherwise noted.
 - c. Clean surfaces prepared for repair free of dust, dirt, masonry chips, oil or other contaminants, rinsed with water, and dried before repair work is begun.

d. Protect surfaces of the structure, and surfaces adjacent to the work area from damage which may result from removal, cleaning, and repair operations.

3.4.5.2 Application of Substitute Repair Materials

- a. Place repair materials to rebuild spalled or damaged areas to match the original surface finish, level, texture, bonding patterns, color and porosity. Match the finished appearance of the substitute repair material patch with the adjacent existing surface. Apply samples to the masonry units in situ.
- b. Do not install repair material in thicknesses exceeding 2 inches. Utilize a Dutchman repair approach or replacement unit for masonry repairs in excess of 2 inches.
- c. Remove loose mortar and masonry prior to installation of the repair material. "Sound" the masonry with a hammer to verify its integrity. If necessary, cut away an additional 1/2 inch of the masonry substrate to ensure the surface to be repaired is solid and stable.
- d. Remove all deteriorated stone, mortar, sealant residue, and previous repair materials back to sound substrate using hammer and chisel or power equipment. Finish edges square to a minimum depth of 1/2 inch. Do not feather edges. Roughen substrate surface to achieve surface roughness required by manufacturer for good bond, but do not overly damage the substrate surface.
- e. Remove sealant residue. Cut out used anchors, threaded rod anchors and/or dowels within the damaged masonry area. Any anchors that are free of rust, solidly embedded, and do not project beyond the solid masonry surface may remain.
- Using clean water and a non-metallic scrub brush, clean dust from surface and pores of the substrate.
- g. Pre-wet the substrate with water prior to the application of the repair material to prevent the substrate from drawing out the moisture too quickly. Re-wet the surface with water again immediately before applying the repair material. Use methods approved by the repair material manufacturer to deliver the substitute repair work as demonstrated.
- h. Follow manufacturers' instructions pertaining to the placement of materials. If the manufacturer requires that installers of a specified product be trained, provide this documentation to the Contracting Officer. Training certificates previously issued by product companies for the application of specified products cannot be substituted for the Project Training "Substitute Repair Material Certificate" on this project.
- i. Masonry and Material Repair Finishes and Color
 - Match the exposed surfaces of masonry and substitute material repair finish, color, texture, and surface detail with the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance.
 - (2) Conceal bond lines between the repaired area and adjacent surfaces.

- (3) Replicate all surface details, including tooling and machine marks.
- (4) Use low-impact energy type equipment in finishing and texturing, which will not weaken the patch or damage the patch bond and the adjacent masonry.

3.4.5.3 Patch Anchors

- a. Provide patch anchors to ensure that the patch is tied to the existing masonry structure at a frequency of at least one patch anchor per 25 square inches of patch plan surface area.
- b. Use small handheld, low-speed rotary masonry drills to produce holes in the existing masonry, within the limits for the patch anchor installation.
 - Drill holes into the existing substrate material of the masonry using rotary (non-hammer) drills making holes with a diameter of 1/8 inch larger than the anchor diameter and a depth of 4 inches, except as otherwise indicated or directed.
 - (2) Drill holes shall not penetrate completely through the masonry, and shall provide at least 1 inch of cover around the drill hole.
 - (3) Clean holes by water blasting to remove drill dust and other debris and then blow dry with filtered, dry, compressed air.
 - (4) Condition drill holes in accordance with the epoxy adhesive manufacturer's recommendations.
- c. Clean anchors to remove all contaminants which may hinder epoxy bond.
- d. Pressure inject adhesive into the back of the drilled holes.
 - Fill holes without spilling excess grout when the anchors are inserted.
 - (2) Insert anchors immediately into the holes.
 - (3) Set back anchors from the exterior face at least 1 inch.
 - (4) Install anchors without breaking or chipping the exposed masonry surface.
 - (5) Use socked or screen tube anchors where voids exist in the masonry units or between the wythes.

3.4.5.4 Cleanup

- a. Protect masonry surfaces from excess grout adhesive and spills.
- b. Leave the surface of the masonry in a clean and uncontaminated condition.
- 3.4.6 Dutchman Repairs
 - a. Select stone for Dutchman repairs from the following three sources listed in order of priority:

- (1) Stone harvested from the same elevation and stone type.
- (2) Approved salvaged stone.
- (3) New stone made from a similar stone type.
- b. Fit the new piece into place with tolerances of no more than plus or minus 1/16-inch.
- c. Provide supporting rods of stainless steel as necessary for the extent of the repair and the location.
- d. Closely blend repairs in with the surrounding original materials.
- 3.4.7 Crack Injection with Dispersed Hydrated Lime (DHL)
- 3.4.7.1 General
 - a. Notify the Contracting Officer as to when and where the installation will occur at least 48 hours prior to start.
 - b. Provide samples to the Government representative from the dispenser during the course of the injection.
 - c. Apply in accordance with the manufacturer's instructions.

3.4.7.2 Application of DHL

- a. Drill 1/8-inch diameter, downward-sloping injection holes. For transverse cracks less than 1/8 inch wide, drill holes through center of crack at 1 to 1.5 inches on center.
- b. Clean out drill holes and cracks with compressed air and potable water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
- c. Inject Dispersed Hydrated Lime using hypodermic needles or pressure ports through holes sequentially, beginning at one end of area and working to opposite end. Do not exceed 10 psi injection pressure. Where possible begin at lower end of injection area and work upward. Inject Dispersed Hydrated Lime until it extrudes from adjacent holes. After Dispersed Hydrated Lime has set, remove excess material and patch injection holes and surface of cracks with appropriate surface treatment.
- 3.4.7.3 Tools and Equipment

Do not use tools and equipment that have not been cleaned of set dispersed hydrated lime.

3.4.8 Steel Lintel Replacement

Provide new steel lintels to match the existing where lintels exhibit extensive corrosion or have deteriorated to the point where damage to the adjacent masonry has occurred. New lintels shall be hot-dipped galvanized, shall be set in a full bed of mortar and shall be provided with a minimum 8 inches of bearing length unless otherwise indicated. Remove and replace existing brick at supports as required in order to allow installation of

the new lintel.

3.4.9 Flashing and Weeps

Install new through-wall flashing at the locations indicated in the drawings and at all replacement lintels. Details shall be as indicated in the drawings.

- 3.4.10 Surface Treatments
- 3.4.10.1 Stucco
 - a. Apply stucco on a clean surface in accordance with ASTM C926 at a thickness matching surrounding historic surfaces.
 - b. Soak the substrate with water to saturated surface dry (SSD) condition prior to application of scratch-coat.
 - c. Apply the scratch-coat and allow to partially-set on the wall surface.
 - d. Use a scratch rake to create the keys into the scratch coat for acceptance of the brown coat.
 - e. Apply the brown coat approximately 24 hours after the scratch coat application. Roughen the brown coat with a wood float with a nail protruding to provide a key for the finish coat.
 - e. Apply the finish coat after the previous coat has initially set.
 - f. If the finish coat must be applied later, soak the brown coat with water to SSD condition prior to the application of the finish coat.
 - g. Apply the textured finish and profile to match the surrounding historic surfaces.

3.4.10.2 Limewashes

- a. Apply limewash using fiber brushes in three thin coats on saturated surface dry (SSD) raw masonry surfaces.
- b. Do not allow the material to dry out before it has had a chance to absorb into the masonry surfaces.
- c. Work from top to bottom of the wall working from the dry-edge.
- d. Allow six hours drying time between coats
- e. Where colors are desired, use natural earth pigments.
- f. Verify all applications, materials and colors through mock ups panels applied to the substrate prior to the start of the work.

3.4.10.3 Water Repellents Infiltration

Application of water proofing is not allowed.

Apply water repellents per manufacturer's instructions.

3.4.10.4 Stone Consolidants

Apply stone consolidants per manufacturer's instructions.

3.5 INSTALLATION OF NEW ELEMENTS

Evaluate new materials and components for both functional and aesthetic impacts on historic structures.

- 3.5.1 Joint Sealant and Lead Flashing
 - a. Test existing sealants for asbestos and PCBs before performing demolition.
 - b. Provide joint sealing as specified in Section 07 92 00 JOINT SEALANTS.

(2) Install sealants in accordance with manufacturer's recommendations.

3.6 FINAL CLEANING

- a. No sooner than 72 hours after completion of the repair work and after joints are sealed, wash down faces and other exposed surfaces of masonry with water applied with a soft bristle brush, then rinse with clean water.
- b. Discolorations that cannot be removed by these procedures, are considered defective work.
- c. Perform cleaning work when temperature and humidity conditions allow the surfaces to dry rapidly.
- d. Protect adjacent surfaces from damage during cleaning operations.
- 3.7 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.8 DEFECTIVE WORK

Repair or replace defective work as directed by Contracting Officer, using approved procedures.

3.9 FINAL INSPECTION

Following completion of the work, inspect the structure for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects. The finish, texture, color and shade, and surface tolerances of the patches shall be inspected to verify that all requirements have been met. Repair surfaces exhibiting defects as directed.

- a. Following completion of the work, inspect the structure for damage, staining, and other distresses.
 - (1) Inspect patches for cracking, crazing, delamination, unsoundness, staining and other defects.
 - (2) Inspect finish, texture, color and shade, and surface tolerances

of the patches to verify that all requirements have been met.

b. Repair surfaces exhibiting defects as directed by Contracting Officer. -- End of Section --

SECTION 04 03 00

CONSERVATION TREATMENT FOR PERIOD MASONRY 11/17

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(201	5;	Suppl	2002-	2016)	Dod	cumen	tation of
	the	Thr	reshol	d Limi	t Val	ues	and	Biological
	Expc	sur	ce Ind	ices				

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM C34	(2017) Standard Specification for Structural Clay Loadbearing Wall Tile
ASTM C67/C67M	(2020) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C170/C170M	(2017) Standard Test Method for Compressive Strength of Dimension Stone
ASTM C216	(2019) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C926	(2020) Standard Specification for Application of Portland Cement-Based Plaster
ASTM C1196	(2014) Standard Test Method for In Situ Compressive Stress Within Solid Unit Masonry Esitmated Using Flatjack Measurements
ASTM C1197	(2014) Standard Test Method for In Situ Measurement of Masonry Deformability Properties Using the Flatjack Method
ASTM C1324	(2015) Standard Test Method for Examination and Analysis of Hardened Masonry Mortar
ASTM C1364	(2019) Standard Specification for Architectural Cast Stone

ASTM C1531	(2015) Standard Test Methods for In Situ Measurement of Masonry Mortar Joint Shear Strength Index
ASTM C1601	(2014) Standard Test Method for Field Measurement of Water Penetration of Masonry Wall Surfaces
ASTM C1713	(2012) Standard Specification for Mortars for the Repair of Historic Masonry
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM E2260	(2012) Standard Guide for Repointing (Tuckpointing) Historic Masonry
ASTM E2659	(2018) Standard Practice for Certificate Programs

NATIONAL PARK SERVICE (NPS)

NPS Hist Prop	(2017) National Standards for the
	Guidelines for Preserving, Rehabilitating,
	Restoring, and Reconstructing Historic
	Bulldings

NPS TPS Brief 1 (2000) Assessing Cleaning and Water-Repellent Treatments for Historic Masonry Buildings

NPS TPS Brief 2 (1998) Repointing Mortar Joints in Historic Masonry Buildings

THE MASONRY SOCIETY (TMS)

TMS MSJC (2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

GSA HPTP 07656-01 Installing Lead Stone Flashing to Protect Masonry Joints

1.2 DEFINITIONS

Terms are defined below as applicable to this project.

1.2.1 Aggregates

The sand component of mortar.

1.2.2 Biocides

A chemical treatment that inhibits, deters, or controls organic growth. Such growth is typically removed by cleaning following biocide treatment..

1.2.3 Binder

The component of mortar that binds together the aggregate particles into a cohesive material.

1.2.4 Dispersed Lime Crack Injection

A repair method in which dispersed lime material is injected into small cracks ranging in width from hairline to 1/8 in by use of needle or syringe.

1.2.5 Consolidant

A chemical product meant to strengthen loose or deteriorated stone.

1.2.6 Dutchman

A repair method in which deteriorated stone is removed in part and replaced with salvaged, harvested or new stone to make a seamless patch.

1.2.7 Harvested

Units removed from inconspicuous areas of the building.

1.2.8 In situ

A term referencing a repair procedure in which the masonry units and mortar remain in place and are repaired without removal from the wall system

1.2.9 Joint Sealant

A flexible, chemical product that is used to create a weather-tight seal at the boundary of masonry units with other units or dissimilar materials.

1.2.10 Lead Flashing

An extruded lead material that is inserted into joints to assist in precluding water entry into the masonry.

1.2.11 Lime Wash

A protective surface treatment comprised of calcium hydroxide particles in suspension in water, along with small amounts of calcium carbonate, silica particles and other minerals.

1.2.12 Mockup

Specific area on the building approved by Contracting Officer to demonstrate the ability to apply, match and install specified materials.

1.2.13 Mortar

A mixture of binders, aggregates, and pigments used for reconstruction, repointing or stucco applications.

1.2.14 New Elements

New, non-historic materials added to masonry structures to aid in their ability to resist loads (typically seismic) or to resist water infiltration.

1.2.15 Patch

The use of substitute repair materials to treat damaged or deteriorated masonry units in situ.

1.2.16 Remediate

An intervention of a historic masonry structure and its component materials with the intent to maintain the original fabric to the greatest extent possible.

1.2.17 Remove

Specifically for historic masonry materials, the term means to detach an item from existing construction to the limits indicated.

1.2.18 Replace

To reinstall an item in its original position (or where indicated) after remedial treatment, or to duplicate and reinstall an entire item with new material; with the original item serving as the pattern for creating the duplicate.

1.2.19 Repoint

To remove existing mortar joints to the specified depth and replace with a mortar that matches in color, texture, and performance with water vapor transmission, bond, hardness, and flexibility compatible with original mortar, as assessed in accordance with ASTM C1713.

1.2.20 Retool

A repair method in which a chisel is used to re-create the surrounding stone texture finish by removing loose pieces of stone.

1.2.21 Stucco

A mixture of binders and aggregates, sometimes including animal hair or fibers used for the repair treatment of existing stucco.

1.2.22 Surface Treatment

The application of traditional materials or contemporary chemical products to the surface of masonry to provide protection to the masonry units and mortar and/or reduce water infiltration.

1.2.23 Test Panel

Specific area on the building approved by the Contracting Officer to demonstrate individual applicator competency and workmanship proficiency prior to the start of restoration work.

1.2.24 Tuckpointing

Often called skim-coating, an American practice of surface repairing mortar joints without the required removal of existing deteriorated mortar beneath. This practice is not recommended for mortar joint repair work on historic masonry. There is also an acceptable British form of tuckpointing practice that involves careful thin penciling of smaller joints within larger ones to give the wall the appearance of an ashlar finish.

1.2.25 Water Repellent

A surface-applied chemcial intended to reduce liquid water entry into a masonry wall without significantly affecting the vapro transmission properties of the original material.

1.2.26 Wall System

A term used to address the fact that masonry structures are comprised of different materials but function holistically, requiring that all restoration and cleaning process take into account the implications of the treatment to the adjacent materials and the building as a whole.

1.2.27 Masonry Treatment Requirement (MTR)

Defined treatments that are required by the specification (contract) documents for project specific repairs to masonry.

1.2.28 Saturated Surface Dry (SSD)

Condition of the wall surface after water has been applied sufficient to saturate more than the surface, then allowed to dry until the surface is dry but the body of the masonry still has moisture.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

Prior to beginning the work of this Section, convene a meeting with the Contracting Officer's Representative(s) to review the requirements of the Quality Control Plan, Project Training Program, installation procedures, location of required mockup areas, and all job conditions and processes. All subcontracting firms involved with this work must participate in this meeting.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G Project Training Program; G Qualifications; G

SD-02 Shop Drawings; G

Photographic Documentation

Structural Upgrades; G

SD-03 Product Data

Qualifications

Cleaning and Restoration Methods; G

Cleaning Materials; G

Biocides

Replacement Mortar And Stucco; G

Mortar Mix; G

Water Repellents Infiltration; G

Stone Consolidants; G

SD-04 Samples

Mock-ups; G

SD-05 Design Data

Calculations for Structural Upgrades; G

SD-06 Test Reports

Testing and Matching

Existing Sealants for Asbestos and PCBs

SD-07 Certificates

Repair Materials

1.5 QUALITY CONTROL

1.5.1 Quality Control Plan

Prior to beginning restoration and cleaning work, submit a written Quality Control Plan. Do not proceed without written approval of the Quality Control Plan. At a minimum, include the following items in the Quality Control Plan:

- a. Describe methods of dust containment during the work specific to the work of this section.
- b. Describe the methods of protecting surrounding masonry, windows, doors, roof, and building trim as well as surrounding landscape. Provide drawings of protection when requested.

- c. Describe the work procedures, materials, and proposed tools to use for each Masonry Treatment Requirement (MTR) specified.
- d. Describe the sequence of each MTR.
- e. Describe how each MTR sequence and the overall construction schedule changes with weather variations and how completed work will be protected.
- f. Describe the methods for surveying original layout and collecting datum points and plumb lines for rebuilding masonry.
- g. Describe the methods for shoring and providing a safe working environment.
- h. Describe the methods for select deconstruction of individual masonry units and tools/methods for cleaning the masonry for reuse.
- i. Describe the method and approach to mortar joint removal.
- j. Describe the method and approach for assuring repair material compatibility with original materials.
- k. Describe the method and approach to cleaning mortar, coating, smears and old patching materials from the masonry surfaces.
- 1. Describe, in detail, the procedures relating to techniques and tools proposed for masonry matching.
- m. Describe the complete masonry removal and matching procedures; include equipment, approach, length of time the masonry will be out of the wall, documentation on mapping the location, and where (on-site or in shop) the masonry units will be repaired.
- n. Describe the procedure for matching of different colors at different locations.
- o. Describe the procedure for mixing and matching of repair materials.
- p. Describe the methods and system by which the use of reclaimed masonry units can be utilized.
- q. Describe the methods for setting masonry back into its original position and maintaining the original bond patterns and joint width.
- r. Describe the methods of transition points where replacement/preservation work will meet the original historic work.
- s. Describe the on-site project training program. Provide the opportunity for workers to be trained in each masonry treatment requirement (MTR) as work proceeds.

1.5.2 Qualifications

- 1.5.2.1 Historic Masonry Consultant
 - a. Secure the services of a historic masonry consultant with a minimum of 10 years experience applying NPS Hist Prop as they relate to the work in this section.

- b. Submit a resume that describes five relevant projects within that period and include how NPS Hist Prop was applied to the work of similar scope and scale and what jurisdiction or agency was involved in approving the work..
- c. The consultant's services include:
 - (1) Investigating the condition of the masonry materials and mortar.
 - (2) Arranging for material analysis in the laboratory
 - (3) Recommending appropriate cleaning methods and materials
 - (4) Recommending restoration options.
 - (5) Providing project specific specifications.
 - (6) Providing an on-site training program.
 - (7) Providing quality control services during construction.
 - (8) Recommending appropriate repair and restoration materials.
- 1.5.2.2 Masonry Firm
 - a. The firm performing the masonry work must have a minimum of five years experience on relevant projects.
 - b. The firm must have completed work similar in material, design, and extent to that indicated for this Project and demonstrate a record of successful in-service performance.
 - c. Proven implementation of NPS Hist Prop and related Preservation Briefs are required.
 - d. Submit a resume that describes the required experience.

1.5.2.3 Field Supervisor

Retain an experienced full-time supervisor on the project site at all times when masonry restoration is in progress. A single individual must be responsible for supervising the historic masonry restoration work throughout the duration of the project.

Submit a resume that describes the required experience.

1.5.2.4 Masonry Applicator

- a. Employ craftspeople who are experienced with and specialize in restoration work of the types they will be performing.
- b. All masonry restoration treatments must be performed by a craftsperson that is familiar with historic masonry construction and has worked on historic masonry projects for at least five years.
- c. Only skilled technicians who are familiar and experienced with the materials and methods specified may be used.

- d. Submit resumes for all historic masonry applicators, demonstrating the required experience.
- 1.5.3 Project Training Definition and Use

In addition to five years demonstrable experience on masonry restoration projects, offer workers project training certificate(s) within the framework of ASTM E2659. Project training certificates are earned by individual workers and issued with the understanding that they are for limited time use, enforceable only to this specific project and for a specific MTR. It is not necessary, nor a requirement of this specificates offered. Rather it is desirable that workers be trained for each project specific task they will perform to ensure the highest quality results from the cleaning and restoration program.

1.5.4 Mortar Analyst

Laboratory mortar analysis equipment should be operated by and results analyzed by trained personnel experienced with analysis of historic masonry mortar.

1.5.5 Documentation

Submit digital photographic documentation of the all phases of masonry restoration, including prior to the start of restoration work.

Provide thorough photo documentation of the project and project details and targeted areas.

1.5.6 Cleaning and Restoration Methods

- 1.5.6.1 General Procedure
 - a. Submit the cleaning and restoration methods, and materials selected for a specific structure for approval before work starts.
 - b. Take into account the total construction system of the building to be worked upon, including different masonry and mortar materials, as well as non-masonry elements which may be affected by the work.
 - c. Utilize mockups to identify the appropriate cleaning and restoration treatment and materials and set the standard for each project task.
 - d. Demonstrate the correct execution of the approved cleaning and restoration methods and materials during the on-site workmanship training program within the framework of ASTM E2659.
- 1.5.6.2 Cleaning Products and Procedures
- 1.5.6.2.1 General Cleaning Requirements
 - a. Establish cleaning products and procedures during the mockup process.
 - b. Select the least aggressive method used to achieve the desired level of cleanliness.
 - c. Where chemical products are selected for cleaning, use them in accordance with the manufacturer's instructions.

1.5.6.2.2 Cleaning Mock-Ups

- a. Demonstrate the materials, equipment, and methods to be used in cleaning in a test section approximately 3 feet by 3 feet.
- b. Locate test patches in inconspicuous areas of the building. The areas tested are subject to approval by the Contracting Officer. The areas tested must exhibit soiling characteristics representative of those larger areas to be cleaned.
- c. Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained.
- d. Conduct tests on areas to be stripped of paint.
- e. Allow tested areas to dry before a determination is made on the effectiveness of a particular treatment.
- 1.5.7 Masonry Restoration Products and Procedures

1.5.7.1 General Restoration Requirements

- a. Do not use masonry or mortar in the work until the mock-ups and the represented material and workmanship have been submitted and approved.
- b. Demonstrate the methods and quality of workmanship to be performed in each masonry treatment requirement (MTR). Provide a mock-up for each MTR indicated.
- 1.5.7.2 General Restoration Mock-Up Requirements
 - a. Throughout restoration, retain approved mock-up panels in undisturbed condition, suitably marked, as a standard for judging completed work.
 - b. Review manufacturer's product data sheets to determine suitability of each product for each surface.
 - c. Apply products using manufacturer-approved application methods, determining actual requirements for application.
 - d. Obtain approval as to the preservation treatment approach, design, and workmanship to include, but not limited to the verification of all material applications and finishes as specified to the requirements of color, texture, profiles, and finishes before proceeding with work.

1.5.7.2.1 Mock-ups

May be performed on inconspicuous sections of actual construction under the same weather conditions expected the remainder of the work.

- a. Location and number as directed.
- b. Size: 3 feet by 3 feet or as appropriate for the repair specified.
- c. Repair unacceptable work.

1.5.7.3 Restoration Mock-Ups

1.5.7.3.1 Repointing

Repoint mortar joints, minimum acceptable mock up dimensions: twelve feet in length - 2/3 horizontal joints and 1/3 vertical joints. Demonstrate method for cutting out mortar joints, preparing wall for repointing, mixing mortar, installing mortar and curing the mortar. Prepare and place repointing mortar in accordance with NPS TPS Brief 2 and in compliance with NPS Hist Prop.

1.5.7.3.2 Retooling Stone Masonry In Situ

Demonstrate treatment technique and methods to retool three deteriorated stone faces in situ in all known historic profile textures identified.

1.5.7.3.3 Masonry Removal and Replacement

Fully remove masonry and replace to specified dimensions and texture. Select size of masonry units representing typical conditions. Return one masonry unit to same location, set to surrounding profile joint width and bond pattern. Set masonry unit using specified mortar. Confirm with Contracting Officer's Representative that the replacement masonry units meet specification requirements for matching and that sufficient quantity required for the work have been identified. Leave one stone dry-set into opening set on wood shims for evaluation and approval of preparation conditions.

1.5.7.3.4 Repair Material

1.5.7.3.4.1 Patching

Apply repair material on at least two masonry units for repair. Include one masonry unit on which to demonstrate proficiency in removing previous patching material and repairing with new substitute repair material. Include the removal of metal anchors at two locations and fill in the holes with repair material on the second masonry unit (where applicable).

1.5.7.3.4.2 Dutchman

Undertake dutchman repairs in two locations, including one that is only cut and prepared for application. Demonstrate the quality of the stone insert, as well as the workmanship and techniques to be performed in the dutchman repairs. Do not proceed with other dutchman repairs until the technique has been approved.

1.5.7.3.5 Crack Repair

Repair one crack, 2 feet in length, using mortar. Repair one crack, 2 feet in length, using dispersed hydrated lime injection technique with appropriate repair material.

1.5.7.3.6 Surface Treatments

Install a minimum 1.5 square meter 16 square foot mockup for each surface treatment on each substrate to be treated. For stucco, demonstrate the means for installing each coat; including mechanical support systems such as wood or metal lath. For water repellents and/or consolidants, demonstrate the equipment and installation procedure. Allow 48 hours for
limewash applications to dry to their final color and appearance.

1.5.7.3.7 New Masonry Elements

Install new components in a manner demonstrating their final installation on the structure.

- 1.6 DELIVERY, STORAGE, AND HANDLING
 - a. Furnish cement in suitable bags used for packaging cements.
 - b. Provide packages with labeling that clearly defines contents, manufacturer, and batch identification.
 - c. Provide detergents, masonry cleaners, paint removers, solvents, epoxies and other chemicals used for masonry cleaning in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer.
 - d. Store materials in weathertight structures which will protect all materials from moisture and contaminants.
 - e. Store accessories to avoid contamination and deterioration.
 - f. Do not use admixtures which have been in storage onsite for six months or longer, or which have been subjected to freezing, unless retested and proven to meet the specified requirements.
- 1.7 PROJECT/SITE CONDITIONS
- 1.7.1 Environmental Requirements
 - a. Do not place materials when weather conditions adversely affect the quality of the finished product.
 - b. Do not place masonry or mortar when the air or surface temperature is below 40 degrees F in the shade and will remain so for at least 48 hours after completion of the work. Heated enclosures may be used to overcome ambient weather restrictions, where such enclosures are feasible.
 - c. Do not place masonry or mortar when air or surface temperature is above 90 degrees F with a wind speed above8 miles per hour and will remain so for at least 48 hours after completion of the work.
 - d. Do not place masonry or mortar when air or surface temperature is above 100 degrees F with or without wind and will remain so for at least 48 ours after completion of the work.
 - e. Do not product or place materials during periods of rain or other precipitation. Stop material placements, and protect all in-place material from exposure, during periods of rain or other precipitation.
 - f. Clean masonry surfaces when air temperatures are above 40 degrees F and will remain so until masonry has dried out, but for not less than 7 days after completion of the work.

- g. Do not perform work in wind conditions that may blow materials onto surfaces not intended to be treated.
- 1.7.2 Masonry Installation Requirements
 - a. Phase work during hot weather by performing work on the shady side(s) of the building during daylight hours and on the daylight side(s) of the building during cooler evening hours to prevent premature evaporation of the water from the mortar.
 - b. Do not use frozen materials or materials mixed or coated with ice or frost. Do not apply materials to frozen surfaces; allow complete thawing prior to installation.
 - c. Do not lower the freezing point of mortar by the use of admixtures or anti-freeze agents. Do not add chlorides or admixtures containing greater than 0.2 percent chlorides to the mortar, per TMS MSJC.
 - d. Prevent mortar from staining the face of the masonry or other exposed surfaces. Immediately remove mortar that comes in contact with such surfaces. Cover partially completed work when work is not in progress. Protect sills, ledges and projections from mortar droppings. Building damage resulting from work of this Section is the Contractor's responsibility. Restore damaged areas to the satisfaction of the Owner at no expense to the Owner. Do not apply products under conditions outside product manufacturer's requirements.

1.8 WARRANTY

1.8.1 Cleaning Warranty

Warrant cleaning procedures for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

1.8.2 Repair Warranty

Warrant repair procedures, including repointing, for a period of two years against: discoloration or mismatch of new mortar to adjacent original historic mortar, discoloration or damage to masonry from improper mortar clean-up, loss of bond between masonry and mortar, fracturing of masonry edges from improper mortar joint preparation procedures or improper mortar formulation, and occurrence of efflorescence from improper repair procedures.

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

2.1.1 General Requirements

Selection of appropriate cleaning products requires a clear understanding of the masonry materials to be cleaned, a rationale for the cleaning, and an understanding of the anticipated level of cleanliness expected from the cleaning program. Overly aggressive cleaning methods and materials can cause subtle, long-term damage to masonry units. Use products that have a minimum 5 year performance record on relevant projects. Select the

products predicated on long-term negative effects to the masonry rather than current level of cleanliness of the comparable structure.

2.1.2 Paint Removers

- a. Provide chemical paint removers that are water soluble, low toxicity products, effective for removal of paint on masonry without altering, damaging, or discoloring the masonry surface.
- b. Provide commercially available poulticing materials designed to adhere to and peel off paint without damaging the underlying masonry or project specific mixtures that include absorbent materials and cleaning solutions which can be demonstrated to do no harm to the masonry.
- 2.1.3 Chemical Cleaners
 - a. Provide commercially available products that have a proven record of cleaning masonry without altering, damaging or discoloring the masonry units, mortar or surrounding materials.
 - b. Provide the associated pre and post treatment material to neutralize the long term effects of the chemicals.

2.1.4 Biocides

Provide commercially available biocides with accompanying product literature containing information on the product as well as the expected service life of the material and any detrimental effects it may have on the masonry or mortar.

2.1.5 Liquid Strippable Masking Agent

Provide manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from the damaging effect of acidic and alkaline masonry cleaners.

2.1.6 Cleaning Implements

Furnish brushes that contain natural or nylon fiber bristles only. Do not use metallic wire brushes. Use scrapers and application paddles made of wood with rounded edges. Metallic tools are not permitted.

2.1.7 Water

Obtain potable water from a local source.

2.2 REPAIR MATERIALS

2.2.1 General

Use repair materials of one type and from one source, when used in repair treatments that will have surfaces exposed in the finished structure.

2.2.2 Mortar and Stucco

2.2.2.1 Testing and Matching

a. Take test specimens of existing mortar and stucco from a sound and

intact representative portion of the structure, at locations by the Contracting Officer's Representative and assess in accordance with ASTM C1713 and ASTM C1324.

- b. Subject a part of the historic mortar sample to petrographic examination and differential thermal analysis, or X-ray diffraction, or analytical chemistry to determine the binder components.
- c. Aggregate Analysis
 - (1) Separate aggregate of the mortar sample from the binder .
 - (2) Rinse the separated aggregate clean with water and dry.
 - (3) Perform sand analysis using a sieve analysis of the aggregate as part of the ASTM C1324 process.
- d. Match the replacement mortar and stucco to the original existing material in color, texture and tooling.

2.2.2.2 Replacement Mortar and Stucco

Provide replacement mortar and stucco that will:

- a. Coexist with the old in a sympathetic, supportive and, if necessary, sacrificial capacity.
- b. Have greater vapor permeability and be softer (measured in compressive strength) than the masonry units.
 - (1) Measure water vapor transmission in accordance with ASTM E96/E96M.
 - (2) Prepare ASTM E96/E96M water vapor transmission specimens with thickness similar to that expected in service, or a maximum of 1/2 inch, whichever is thinner.
- c. Be as vapor permeable, and as soft, or softer, (measured in compressive strength) than the existing historic mortar or stucco.

2.2.2.3 Binder Content

Provide binder type or mixture of mortar (and stucco) with a cement, lime, or combination thereof consistent with the original existing mortar (and stucco) content in order to provide uniform durability, weathering characteristics, and the same, or better, life-cycle performance expectations.

2.2.2.4 Repointing Mortar

Repointing mortar may be site mixed, Type S, Type N, Type L, Type O and Type K.

2.2.2.5 Admixtures

Do not use admixtures in the mortar or stucco unless specifically approved in writing by the Contracting Officer.

2.2.3 Crack Injection

- a. Comply with the dispersed hydrated lime manufacturer's written instructions.
- b. Inject cracks that are no greater than 1/8 inch in width and masonry is soundly bonded but cracked.
- c. Inject the full length of the cracks unless specifically instructed otherwise.
- 2.2.4 Replacement Masonry Materials
- 2.2.4.1 Clay Brick
 - a. Provide replacement brick matching color, shape, size, texture, appearance, and thermal expansion properties of the existing historic brick.
 - b. Test brick in comparison to the original existing historic brick using ASTM C67/C67M.
 - c. Do not use reclaimed brick unless approved by Contracting Officer.
 - d. Provide brick meeting the requirements of ASTM C216 Grade SW, including a rating of "not effloresced", unless otherwise specified.
- 2.2.4.2 Stone
 - a. Provide replacement sotne matching type, color, shape, size, texture, finish-profile, and compressive strength of the existing historic stone units.
 - b. Test replacement stone in comparison to the existing historic stone using ASTM C170/C170M.
- 2.2.4.3 Terra Cotta
 - a. Provide replacement terra cotta matching color, shape, size, texture and finish-profile of the existing historic terra cotta units.
 - b. Test replacement terra cotta in comparison to the existing historic terra cotta using ASTM C34.
- 2.2.4.4 Architectural Precast Stone
 - a. Provide replacement architectural precast stone matching color, shape, size, texture and finish-profile of the existing historic architectural precast stone units.
 - b. Test replacement architectural precast stone in comparison to the existing historic architectural precast stone using ASTM C1364.
- 2.2.5 Surface Treatments
- 2.2.5.1 General

Provide commercially available coatings with water vapor permeabillity of 0.98 or greater, as measured in accordance with ASTM E96/E96M, including

silanes and siloxanes.

2.2.5.2 Consolidants

Provide commercially available consolidants designed to strengthen loose or deteriorated stone without damaging intact stone or reducing water vapor permeability below 0.98, as measured in accordance with ASTM E96/E96M.

2.2.5.3 Water Repellents

Provide commercially available water repellents designed to preclude water droplet entry into the masonry walls without reducing water vapor permeability below 0.98. as measured in accordance with ASTM E96/E96M.

- 2.2.6 Miscellaneous Materials
- 2.2.6.1 Cementitious Grout

Use cementitious grout, recommended by the manufacturer for the application, to bond steel anchors to masonry.

- 2.2.6.2 Metal Attachments
 - a. Provide threaded or deformed stainless steel anchors for spall repairs, size as indicated.
 - b. Provide other plates, angles, anchors, and embedments conforming to ASTM A36/A36M, prime painted with inorganic zinc primer.

2.2.6.3 Lead Flashing

Provide commercially available lead flashing conforming to GSA HPTP 07656-01.

2.3 EQUIPMENT

2.3.1 Cleaning Equipment

Provide cleaning equipment that does not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

2.3.1.1 Sandblasting

Use of sandblasting equipment is not allowed for cleaning masonry surfaces.

2.3.1.2 Water Blasting

- a. Provide water blasting equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment.
- b. Do not operate the equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints. Operate the equipment at a discharge capacity of 55 to 400 psi and 2.5 to 3 gpm for general surface cleaning operations.
- c. Provide water tank and auxiliary re-supply equipment of sufficient capacity to permit continuous operations.
- d. Provide protective covers and barriers as required to prevent

over-spray onto adjacent surfaces.

2.3.1.3 Alternative Blasting Equipment

- a. Alternative blasting methods require equipment designed to discharge sponges, walnut shells, ice, soda and other friable materials.
- b. Operate equipment in accordance with manufacturer's recommendations and maintain in good working order.
- c. Do not operate equipment at a pressure which will cause etching or other damage to the masonry surface or mortar joints.
- d. Determine discharge capacity on a case by case basis during the mockup test panel demonstration and approval process.
- e. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.2 Spray Equipment

- a. Provide spray equipment for chemical cleaners with low-pressure tanks or chemical pumps suitable for chemical cleaner indicated, and equipped with stainless steel, cone-shaped spray-tip.
- b. Disperse water through a fan-shaped spray tip at an angle of not less than 15 degrees.
- c. Deliver water at a pressure not greater than 400 psi and at a volume between 2.5 and 3 gpm.
- d. Deliver heated water at flow rates indicated maintaining between 140 and 180 degrees F.

2.3.3 Drilling Equipment

- a. Use standard small, powered, handheld masonry drills, commonly used for drilling small holes in concrete and masonry to drill holes in masonry for patch anchors and other applications.
- b. Use drills in rotary mode only. Do not use impact type drills.
- 2.3.4 Compressed Air Supplies
 - a. Use compressed air equipment that delivers clean, oil and moisture free compressed air at the surface to be cleaned. Use a minimum of two in-line air filters to remove oil and moisture from the air supply.
 - b. Test the compressed air supply during each shift for the presence of oil and moisture.
- 2.3.5 Material Handling and Associated Equipment
- 2.3.5.1 Mixing, Transporting, and Placing Job Materials
 - a. Provide equipment used for mixing, transporting, placing, and confining masonry and mortar placements capable of satisfactorily mixing material and supporting uninterrupted placement operations.

- b. Provide equipment used for mixing, conveying, and placing of materials that is clean, free of old materials and contaminants, and in conformance with material manufacturer's recommendations.
- 2.3.5.2 Associated Equipment

Provide associated equipment, such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools, as required to ensure a continuous supply of material and operation control.

2.4 Mortar Mix

- 2.4.1 General
 - a. Proportion materials appropriately with regard to the effect of moisture content on the individual components (cement, sand and lime).
 - b. Batch materials using volumetric measurement devices and consistently consolidate the material in these devices to ensure the uniformity of the mortar. Do not batch by shovel counts.
- 2.4.2 Batching
 - a. Utilize a calibrated measuring device for batching Portland cement.
 - b. Utilize a calibrated measuring device for batching hydrated lime or lime putty.
 - c. Utilize a calibrated measuring device for batching the sand.
- 2.4.3 Cement and Lime Proportions
 - a. Fill the measuring device with portland cement, hydrated lime or lime putty.
 - b. Briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush.
 - c. For dry hydrate lime, fill the measuring device using a minimum of three lifts, strike the bottom of the measuring device against the ground a minimum of ten times for each lift and then strike the top flush. Mix dry hydrate lime to a wet paste that is 40 to 42 percent solid.
 - d. For lime putty briskly strike the bottom of the measuring device against the ground a minimum of ten times and then strike the top flush. No additional lime is required when measuring from putty.
- 2.4.4 Sand Proportions
 - a. Proportion sand when the sand is in saturated surface dry (SSD), loose damp condition.
 - b. Proportion the sand by filling a measuring device using a minimum of three lifts, striking the sides a minimum of ten times, and then striking the top flush.

PART 3 EXECUTION

3.1 EXAMINATION

- a. Undertake masonry renovation only after complete evaluation and analysis of the areas to be repaired are completed, including sampling and testing of the existing mortar to determine its composition and qualities. Do not start repair work until conditions that have caused masonry deterioration have been identified and corrected.
- b. Use the gentlest means to perform the work and take the greatest of care to ensure that the historic materials are not damaged in the process of the work, as established by mock-ups and testing.
- c. In addition to requirements in this Section, comply with NPS Hist Prop.
- 3.1.1 Field (In Situ) Mortar Examination
 - a. Detect cracks, degradation and de-bonding from the surrounding masonry.
 - b. Determine previous surface coating treatments that may be contributing to the current conditions.
 - c. Compare the bedding mortar with the pointing mortar and determine the cross-sectional characteristics of the wall.
 - d. Determine the level of moisture movement in the in situ mortar, and if the mortar or masonry units are handling the brunt of the water movement through the wall.
 - e. Evaluate in situ mortar joint shear strength in accordance with ASTM C1531.
- 3.1.2 Taking and Preparation of Samples
 - a. Take and analyze samples of unweathered original historic mortar and different types of mortar in the structure in order to match the new mortar to be used for repointing.
 - b. Remove three or four samples of each type of mortar to be matched with a hand chisel from several locations on the building. Mortar samples to be intact pieces with a minimum size of 1 ounce.
 - c. Set aside the largest sample for comparison with the repointing mortar.
 - d. Place the remaining samples in labeled, sealed sample bags for transport to the laboratory for evaluation per Part 2 of this Specification.

3.2 PREPARATION

3.2.1 Protection

- a. Protect persons, motor vehicles, adjacent surfaces, surrounding buildings, equipment, and landscape materials from chemicals used and runoff from cleaning and paint removal operations.
- b. Erect temporary protection covers, which will remain in operation during the course of the work, over pedestrian walkways and at

personnel and vehicular points of entrance and exit.

- c. Protect the interior of buildings from the weather, cleaning, and repair operations at all times.
- d. Do not expose workers to chemical substances in excess of the limits established by ACGIH 0100. Comply with more stringent regulations where applicable.
- 3.2.2 Surface Preparation
 - a. Do not proceed with cleaning until mock-ups have been approved.
 - b. Do not proceed with repointing or stucco until existing mortar and stucco have been analyzed and suitable repair materials have been determined.
 - c. Do not proceed with restoration work until the cause of observed distresses have been identified and corrected.
 - d. Do not proceed with surface treatments until all other restoration work has been completed.
- 3.2.3 Equipment and Techniques Demonstration
 - a. Demonstrate equipment and techniques of operation in an approved location.
 - b. Assemble dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, at the work site with sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required.
 - c. Maintain the equipment in good working condition throughout the project.
- 3.3 MASONRY CLEANING

3.3.1 General

- a. Exercise caution against over-cleaning of surfaces, which may be detrimental, and which may remove desirable historic surface details or patinas. For example, if cleaning reveals unexpected joint painting or historic signage; suspend the cleaning action, protect the exposed area and notify the Contracting Officer.
- b. Do not damage or mar historic materials in the process of cleaning.
- c. Perform cleaning per NPS TPS Brief 1.
- d. Protect open joints to prevent water and cleaner intrusion into the interior of the structure.
- e. Protect non-masonry materials and severely deteriorated masonry by approved methods prior to initiation of cleaning operations.
- f. Remove all organic and inorganic contaminants from the surface and pores of the substrate, without causing any short or long-term negative consequences.

- g. Clean surfaces evenly with no evidence of streaking or bleaching.
- h. Do not affect the density, porosity, or color of the existing masonry or mortar.
- i. Maintain a neutral pH on surface of cleaned masonry units.
- j. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results.
- k. Proceed with cleaning in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.
- 1. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry.
- m. Use the following sequence of methods to determine the least aggressive, effective cleaning method:
 - (1) Water with non-metallic brushes (cold water).
 - (2) Water with mild soap
 - (3) Water with stronger soap
 - (4) Water with stronger soap plus ammonia
 - (5) Water with stronger soap plus vinegar (but not on calcareous masonry)
 - (6) Stronger chemical cleaners, only when above methods are determined to be ineffective by the Contracting Officer
- 3.3.2 Chemical Cleaners
 - a. Do not use chemical cleaners without approval from the Contracting Officer.
 - b. Do not use acidic chemical cleaners on limestone, marble, concrete and other calcareous (calcium containing) masonry materials. If chemical cleaners are used on such materials, use alkaline based cleaners with neutralizing afterwashes.
- 3.3.3 Paint Removal
 - a. Prior to removal, test existing paint for lead in accordance with Section 02 83 00 LEAD REMEDIATION.
 - b. Clean areas where paint is to be removed with water and detergent solution to remove surface dirt. Rinse and allow to dry.
 - c. Remove paint and other coatings from masonry surfaces in areas indicated prior to general cleaning.
 - d. Do not damage or mar masonry in the process of paint removal.
 - e. Apply chemical paint removers in accordance with manufacturer's instructions.
 - f. Protect surrounding painted surfaces from exposure to chemical paint removers to avoid damage.

- g. Remove paint containing lead in accordance with Section 02 83 00 LEAD REMEDIATION.
- 3.3.4 Water Cleaning
- 3.3.4.1 Pressure Spraying
 - a. Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment.
 - b. Unless otherwise indicated, wash the surface with clean, low pressure water (pressure of less than 55 psi and 2.5 to 3 gpm discharge) and hold spray nozzle not less than 12 inches from surface of masonry.
 - c. Apply water side to side and top to bottom in overlapping bands to produce uniform coverage.
- 3.3.4.2 Hand Scrubbing
 - a. Scrub surfaces to be cleaned to remove surface contaminants.
 - b. Pre-wet surfaces and use hand-held natural bristle or nylon brushes.
 - c. Do not use wire brushes.
- 3.3.4.3 Rinsing
 - a. Rinse scrubbed surfaces clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working from top to bottom of each treated area.
 - b. Remove all traces of contaminants and cleaning solutions.
- 3.3.5 Chemical Cleaning
- 3.3.5.1 General
 - a. Chemical cleaning is the use of any product in addition to water, including detergents, ammonia, vinegar, and bleach.
 - b. Use gentlest means possible to achieve the desired result as determined by test patches.
 - c. Proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other.
 - d. Provide uniform coverage of all surfaces, including corners, moldings, interstices and produce an even effect without streaking or damage to masonry.
 - e. Do not apply chemical cleaners to the same masonry surfaces more than twice.

3.3.5.2 Surface Prewetting

a. Wet masonry surfaces to be cleaned with chemical cleaners with water using a low pressure spray before application of any cleaner.

- b. Prewet walls working from top to bottom, except work bottom to top on one-story walls.
- c. Do not prewet masonry surface prior to applying biocides.
- 3.3.5.3 Acidic Chemical Cleaning
 - a. Apply acidic chemical cleaners according to manufacturer's instructions.
 - b. Do not apply acidic chemical cleaners to masonry with high calcium content (e.g. marble, limestone.
 - c. Apply acidic cleaners to masonry surfaces by low pressure spray 50 psi max., roller, or brush.
 - d. Leave cleaner on on masonry surface for the time period recommended by the manufacturer.
 - e. Employ manual scrubbing by brushes as indicated by test patches for the specific location.
 - f. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaner.
- 3.3.5.4 Alkaline Chemical Cleaning

3.3.5.4.1 Prewash Phase

- a. Apply alkaline chemical cleaners to masonry surfaces according to manufacturer's instructions, by low pressure spray 50 psi max., roller, or brush.
- b. Leave cleaner on masonry surface for the time period recommended by the manufacturer.
- c. Employ manual scrubbing by brushes as indicated by test patches for the specific location.
- d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water.

3.3.5.4.2 Afterwash Phase

- a. Immediately after rinsing of alkaline cleaned surfaces, apply a neutralizing afterwash to the cleaned masonry areas.
- b. Apply neutralizing afterwash according to manufacturer's instructions, by low pressure spray 50 psi max., roller, or brush.
- c. Leave afterwash on masonry surface for the time period recommended by manufacturer.
- d. Rinse cleaned surfaces with a low-to-moderate pressure spray of water to remove all traces of chemical cleaners.

3.3.5.5 Rinsing and pH Testing

a. Determine the pH of masonry surfaces that have been chemically cleaned using pH monitoring pencils or papers.

- b. Rinse chemically cleaned masonry, using a low pressure spray, until a neutral pH (7) reading is obtained from the masonry unit surface.
- 3.4 MASONRY REPAIR
- 3.4.1 General
 - a. Match repaired surfaces with adjacent existing surfaces in all respects.
 - b. Demonstrate the materials, methods and equipment proposed for use in the repair work in mock-ups, as specified in PART 2.
 - c. Use products in accordance with the manufacturer's instructions.
 - d. Proceed with masonry repair only after the cause of deterioration has been corrected.
 - e. Assist Historic Masonry Consultant with performing field investigation to determine the causes and extent of degradation. Utilize the following techniques.
 - Employ a field microscope to closely assess the conditions at the surface of the mortar and masonry units. Detect cracks and assess for degradation and debonding from the surrounding masonry. Detect previous surface coating treatments on the mortar and masonry that may be contributing to the current conditions.
 - (2) Employ a boroscope to examine mortar deeper in the joint. Compare the bedding mortar with the pointing mortar and ascertain the cross-sectional characteristics of the wall.
 - (3) Employ moisture meters to determine the level of moisture in the mortar and masonry, and if the mortar or masonry units are handling the brunt of the water movement through the wall. Infrared thermography, employed by a trained investigator, can provide additional information on the moisture conditions.
 - (4) Employ RILEM tubes using the method of RILEM II.4 or water penetration testing in accordance with ASTM C1601 to determine the rate of water uptake into the masonry.
 - (5) To access the physical characteristics of hard mortar, use a spring loaded or pendulum impact device to determine surface hardness as an indicator of relative compressive strength. For evaluating softer mortars, mortar integrity deeper in the wall, and the condition of the masonry units, use a drill resistance tool by an experienced consultant.
 - (6) Utilize technologies such as ground penetrating radar or metal detection equipment to map metal reinforcement and embedments in the wall.
 - (7) Use flat jack or jacks and rams to gather information on in situ compressive stress (ASTM C1196, masonry compressive response ASTM C1197, and mortar joint shear strength ASTM C1531.
- 3.4.2 Repointing Masonry

Repoint masonry in accordance with NPS TPS Brief 2, using ASTM E2260 as a

reference guide.

3.4.2.1 Wall Preparation

- a. Remove old caulking, grout, or non-original mortar from previously repaired joints to a minimum depth of 2.5 times the width of the joint. Cut all joints (unless otherwise noted) back to sound, solid, back up material. Leave a clean, square face at the back of the joint to provide for maximum contact of repointing mortar.
- b. Shallow or feather edging is not permitted. Remove loose particles from joints. Clean joints, followed by blowing with filtered, dry, compressed air or vacuum.
- c. Cut out existing horizontal mortar joints (bed joints) that are filled with a hard Portland mortar using a diamond blade that is narrower than the joint width. Cut out the middle one-third of the mortar joint using a rotary power saw. Remove the remaining mortar from the masonry joints by hand using masonry chisels or pneumatic carving tools.
- d. Do not use rotary power saws to cut out vertical joints (head joints) . Remove all vertical head joints by hand using a pneumatic carving tool, or hammer and chisel.
- e. Remove existing historic lime-based mortar using only small-headed chisels that are no wider than half the width of the existing masonry joints. Pneumatic air carving chisels are permitted as are specially designed mortar removal reciprocating tools (i.e. Arbortech Saw).
- f. Do not widen the existing masonry joints. Do not chip or spall the surrounding masonry edges in the process of mortar removal. Damage to surrounding masonry units resulting from rotary blade over running is not permitted. Damages to adjacent materials exceeding 1/8 inch in size are the responsibility of the contractor and must be repaired by removal and replacement of damaged materials.
- g. Permit applicators to be trained at the project site in this masonry treatment requirement.
- 3.4.2.2 Presoaking Masonry / Mortar Consistency / Lifts
 - a. Use the same mortar as the repointing mortar for setting the replacement masonry.
 - b. Soak exposed surfaces of historic masonry adjacent to joint with water prior to repointing.
 - c. Allow time for excess water to run off and evaporate prior to repointing. Joint surfaces must be damp but free from standing water.
 - d. Maintain a water sprayer on site at all times during the repointing process.
 - e. The mortar material must resemble the consistency of brown sugar during installation. This drier consistency enables the material to be tightly packed into the joint, allows for cleaner work, and prevents shrinkage cracks as the mortar cures.
 - f. Allow mixed repointing mortar to stand for not less than one-half hour

and not more than one and one-half hours for pre-hydration to reduce post-curing shrinkage. After this time, water can be added to small batches by hand to bring the mortar to a stiff yet workable consistency. Use repointing mortar within two and one-half hours after initial mixing and within one hour after adding water to bring the mortar to a working consistency. Retempering of the mortar to replace evaporated water is permitted within these time frames.

- g. Point joints in layers or "lifts" where the joints are deeper than 1-1/4 inch. Apply in layers not less than 1/2 the depth but not more than 1-1/4 inch or until a uniform depth is formed.
- 3.4.2.3 Compression / Joint Finish / Curing
 - a. Compress each layer thoroughly.
 - b. When mortar is thumbprint hard at the surface of the wall, finish the joints to match the original historic joint profile.
 - c. For Type L mortar:
 - Allow water evaporation from the freshly repointed walls in order to initiate the carbonation process in high lime content mortars. The carbonation of lime mortar initially requires wet-and-dry cycles, which can be created by water misting the joints after the mortar application when dry weather conditions prevail. Finish the joint profile before these cycles are started.
 - (2) Depending on the environmental conditions (temperature and humidity), carry out water misting until a full nine alternating wet-and-dry cycles are completed.
 - (3) Adjust curing methods to ensure that the repointing mortar is damp without eroding the surface of the mortar.
- 3.4.2.4 Protection
 - a. Keep the mortar from drying out too quickly or from becoming too wet.
 - b. Protect mortar from direct sun and high winds for the first 72 hours after installation or from driving rain for the first 24 hours, using plastic sheeting if necessary. Do not create a greenhouse effect by sealing off air movement in an attempt to protect the wall with plastic. Allow for air circulation to facilitate the carbonation process.
- 3.4.3 Retooling Stone Masonry In situ
 - a. Scale off all loose pieces of original stone from masonry intended to remain in place, including surface material in powder or granular form and detachments of planer elements, spalls and chips.
 - b. Assess all stone on building by sounding (tapping with a small hammer) or by using impact echo (for massive stones), surface penetrating radar, or infrared thermography in order to distinguish fully intact stone from those in which delamination may be hidden or pieces of unstable material may not be immediately visible.
 - c. Remove and replace stone units that are designated for retooling in

situ, but develop a solid stone substrate that is no longer in plane or plumb with the surrounding stone masonry surfaces after chiseling is complete.

- 3.4.4 Masonry Removal and Replacement
 - a. Before removing any deteriorated masonry units, establish bonding patterns, levels and coursings. Remove masonry that has deteriorated or is damaged beyond repair, as determined through investigation and evaluation. Carefully demolish or remove entire units from joint to joint, without damaging surrounding units in a manner that permits replacement with full-size units. Support and protect remaining masonry work that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition. Notify Contracting Officer of unforeseen detrimental conditions including voids, cracks, bulges, and loose masonry units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items. Remove as many whole masonry units as possible without damage.
 - b. Remove mortar, loose particles, and soil from masonry by cleaning with hand chisels, non-metallic brushes, and water.
 - c. Remove sealants by cutting close to masonry units with utility knife and cleaning with solvents. Clean surrounding masonry areas by removing mortar, dust, and loose particles in preparation for replacement.
 - d. Replace removed masonry with masonry units removed from inconspicuous areas of the building, where possible, or with new masonry units matching the existing units. Butter vertical joints for full width before setting and set units in full bed of mortar, unless otherwise indicated. Remove mortar used for laying/setting masonry units before mortar sets to the repointing depth of the surrounding area. Repoint new mortar joints in repaired area to comply with requirements for repointing at existing masonry units.
 - e. If a few isolated masonry units are to be replaced, remove each without disturbing the surrounding masonry. Remove deteriorated masonry units and mortar requiring replacement by hand chiseling. Do not damage adjoining masonry units during the removal of deteriorated units and mortar.
 - f. Test the new element for fitting into its space without mortar. Use wedges made from non-expanding, non-corrosive material such as plastic to support and align the new unit, cover them with at least 1-1/2 inches of mortar when pointing is complete.
 - g. Cover the four sides of the space with sufficient mortar to ensure that there will be no air spaces when the new unit is set. Fill the back of the space with mortar only if it matches existing construction.
 - h. Line up and set the new unit by tapping it into place with a wooden or rubber mallet. Align the face of new unit with that of existing masonry.
 - i. Repoint joints to match the rest of the wall after new units have been properly installed and adjusted.

- j. Clean replacement areas with a non-metallic brush and water to remove excess mortar.
- 3.4.5 Material Repair

Repair or replace original historic masonry materials only if surfaces are extensively deteriorated (surface missing to a depth of 4 inches or more) or are threatening the safety of the structure or individuals. If additional damage is found, notify the Contracting Officer. Repairs and replacements must match the materials, colors, and finish of the existing historic masonry as closely as possible.

- 3.4.5.1 Selective Demolition
 - a. Remove unsound, weak, or damaged masonry and mortar in areas as indicated.
 - b. Remove loose particles, laitance, spalling, cracked, or debonded masonry and mortar and foreign materials with hand tools unless otherwise noted.
 - c. Clean surfaces prepared for repair free of dust, dirt, masonry chips, oil or other contaminants, rinsed with water, and dried before repair work is begun.
 - d. Protect surfaces of the structure, and surfaces adjacent to the work area from damage which may result from removal, cleaning, and repair operations.

3.4.5.2 Application of Substitute Repair Materials

- a. Place repair materials to rebuild spalled or damaged areas to match the original surface finish, level, texture, bonding patterns, color and porosity. Match the finished appearance of the substitute repair material patch with the adjacent existing surface. Apply samples to the masonry units in situ.
- b. Do not install repair material in thicknesses exceeding 2 inches. Utilize a Dutchman repair approach or replacement unit for masonry repairs in excess of 2 inches.
- c. Remove loose mortar and masonry prior to installation of the repair material. "Sound" the masonry with a hammer to verify its integrity. If necessary, cut away an additional 1/2 inch of the masonry substrate to ensure the surface to be repaired is solid and stable.
- d. Remove all deteriorated stone, mortar, sealant residue, and previous repair materials back to sound substrate using hammer and chisel or power equipment. Finish edges square to a minimum depth of 1/2 inch. Do not feather edges. Roughen substrate surface to achieve surface roughness required by manufacturer for good bond, but do not overly damage the substrate surface.
- e. Remove sealant residue. Cut out used anchors, threaded rod anchors and/or dowels within the damaged masonry area. Any anchors that are free of rust, solidly embedded, and do not project beyond the solid masonry surface may remain.
- f. Using clean water and a non-metallic scrub brush, clean dust from

surface and pores of the substrate.

- g. Pre-wet the substrate with water prior to the application of the repair material to prevent the substrate from drawing out the moisture too quickly. Re-wet the surface with water again immediately before applying the repair material. Use methods approved by the repair material manufacturer to deliver the substitute repair work as demonstrated.
- h. Follow manufacturers' instructions pertaining to the placement of materials. If the manufacturer requires that installers of a specified product be trained, provide this documentation to the Contracting Officer. Training certificates previously issued by product companies for the application of specified products cannot be substituted for the Project Training "Substitute Repair Material Certificate" on this project.
- i. Masonry and Material Repair Finishes and Color
 - Match the exposed surfaces of masonry and substitute material repair finish, color, texture, and surface detail with the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance.
 - (2) Conceal bond lines between the repaired area and adjacent surfaces.
 - (3) Replicate all surface details, including tooling and machine marks.
 - (4) Use low-impact energy type equipment in finishing and texturing, which will not weaken the patch or damage the patch bond and the adjacent masonry.

3.4.5.3 Patch Anchors

- a. Provide patch anchors to ensure that the patch is tied to the existing masonry structure at a frequency of at least one patch anchor per 4 square inches of patch plan surface area; specific locations for patch anchors must be as indicated.
- b. Use small handheld, low-speed rotary masonry drills to produce holes in the existing masonry, within the limits for the patch anchor installation.
 - Drill holes into the existing substrate material of the masonry using rotary (non-hammer) drills making holes with a diameter of 1/8 inch larger than the anchor diameter and a depth of 4 inches, except as otherwise indicated or directed.
 - (2) Drill holes must not penetrate completely through the masonry, and must provide at least 1 inch of cover around the drill hole.
 - (3) Clean holes by water blasting to remove drill dust and other debris and then blow dry with filtered, dry, compressed air.
 - (4) Condition drill holes in accordance with the epoxy adhesive manufacturer's recommendations.
- c. Clean anchors to remove all contaminants which may hinder epoxy bond.

- d. Pressure inject adhesive into the back of the drilled holes.
 - Fill holes without spilling excess grout when the anchors are inserted.
 - (2) Insert anchors immediately into the holes.
 - (3) Set back anchors from the exterior face at least 1 inch.
 - (4) Install anchors without breaking or chipping the exposed masonry surface.
 - (5) Use socked or screen tube anchors where voids exist in the masonry units or between the wythes.

3.4.5.4 Cleanup

- a. Protect masonry surfaces from excess grount adhesive and spills.
- b. Leave the surface of the masonry in a clean and uncontaminated condition.
- 3.4.6 Dutchman Repairs
 - a. Select stone for Dutchman repairs from the following three sources listed in order of priority:
 - (1) Stone harvested from the same elevation and stone type.
 - (2) Approved salvaged stone.
 - (3) New stone made from a similar stone type.
 - b. Fit the new piece into place with tolerances of no more than plus or minus 1/16-inch.
 - c. Provide supporting rods of stainless steel as necessary for the extent of the repair and the location.
 - d. Closely blend repairs in with the surrounding original materials.
- 3.4.7 Crack Injection with Dispersed Hydrated Lime (DHL)
- 3.4.7.1 General
 - a. Notify the Contracting Officer as to when and where the installation will occur at least 48 hours prior to start.
 - b. Provide samples to the Government representative from the dispenser during the course of the injection.
 - c. Apply in accordance with the manufacturer's instructions.
- 3.4.7.2 Application of DHL
 - a. Drill 1/8-inch diameter, downward-sloping injection holes. For transverse cracks less than 1/8 inch wide, drill holes through center of crack at 1 to 1.5 inches on center.

- b. Clean out drill holes and cracks with compressed air and potable water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
- c. Inject Dispersed Hydrated Lime using hypodermic needles or pressure ports through holes sequentially, beginning at one end of area and working to opposite end. Do not exceed 10 psi injection pressure. Where possible begin at lower end of injection area and work upward. Inject Dispersed Hydrated Lime until it extrudes from adjacent holes. After Dispersed Hydrated Lime has set, remove excess material and patch injection holes and surface of cracks with appropriate surface treatment.
- 3.4.7.3 Tools and Equipment

Do not use tools and equipment that have not been cleaned of set dispersed hydrated lime.

3.4.8 Surface Treatments

3.4.8.1 Stucco

- a. Apply stucco on a clean surface in accordance with ASTM C926 at a thickness matching surrounding historic surfaces.
- b. Soak the substrate with water to saturated surface dry (SSD) condition prior to application of scratch-coat.
- c. Apply the scratch-coat and allow to partially-set on the wall surface.
- d. Use a scratch rake to create the keys into the scratch coat for acceptance of the finish coat.
- e. Apply the finish coat approximately 24 hours after the scratch coat application.
- f. Soak the scratch coat with water to SSD condition prior to the application of the finish coat.
- g. Apply the textured finish and profile to match the surrounding historic surfaces.

3.4.8.2 Limewashes

- a. Apply limewash using fiber brushes in three thin coats on saturated surface dry (SSD) raw masonry surfaces.
- b. Do not allow the material to dry out before it has had a chance to absorb into the masonry surfaces.
- c. Work from top to bottom of the wall working from the dry-edge.
- d. Allow six hours drying time between coats
- e. Where colors are desired, use natural earth pigments.
- f. Verify all applications, materials and colors through mock ups panels applied to the substrate prior to the start of the work.

3.4.8.3 Water Repellents Infiltration

Application of water proofing is not allowed.

Application of water repellents may be performed upon Contracting Officer approval of the recommendation and justification, by the historic masonry consultant, that no other means will control water infiltration. Apply water repellents per manufacturer's instructions.

3.4.8.4 Stone Consolidants

Use of stone consolidants requires Contracting Officer approval of the historic masonry consultants recommendation, including justifying data. Apply stone consolidants per manufacturer's instructions.

3.5 INSTALLATION OF NEW ELEMENTS

Evaluate new materials and components for both functional and aesthetic impacts on historic structures.

3.5.1 Structural Upgrades

For mechanical anchors used to reinforce masonry structures, provide design by a registered professional structural engineer. Strengthening measures must take into account the current loads and stresses in the structure and the nature in which the building has historically managed thermal and other environmental changes or cycles.

Submit manufacturers literature, design analysis and detail drawings for the proposed additional materials.

- 3.5.2 Joint Sealant and Lead Flashing
 - a. Test existing sealants for asbestos and PCBs before performing demolition.
 - b. Provide joint sealing as specified in Section 07 92 00 JOINT SEALANTS.
 - (1) Augmentation with lead flashing is allowed for upward facing joints exposed to weather.
 - (2) Install sealants and lead flashing in accordance with manufacturer's recommendations.

3.6 FINAL CLEANING

- a. No sooner than 72 hours after completion of the repair work and after joints are sealed, wash down faces and other exposed surfaces of masonry with water applied with a soft bristle brush, then rinse with clean water.
- b. Discolorations that cannot be removed by these procedures, are considered defective work.
- c. Perform cleaning work when temperature and humidity conditions allow the surfaces to dry rapidly.
- d. Protect adjacent surfaces from damage during cleaning operations.

3.7 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.8 DEFECTIVE WORK

Repair or replace defective work as directed by Contracting Officer, using approved procedures.

3.9 FINAL INSPECTION

Following completion of the work, inspect the structure for damage, staining, and other distresses. Inspect the patches for cracking, crazing, delamination, unsoundness, staining and other defects. Inspect the finish, texture, color and shade, and surface tolerances of the patches to verify that all requirements have been met. Repair surfaces exhibiting defects as directed.

- a. Following completion of the work, inspect the structure for damage, staining, and other distresses.
 - (1) Inspect patches for cracking, crazing, delamination, unsoundness, staining and other defects.
 - (2) Inspect finish, texture, color and shade, and surface tolerances of the patches to verify that all requirements have been met.
- b. Repair surfaces exhibiting defects as directed by Contracting Officer.

-- End of Section --

SECTION 04 20 00

UNIT MASONRY 11/15

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONCRETE INSTITUTE (ACI)

(2014) Code Requirements for Determining
Fire Resistance of Concrete and Masonry
Construction Assemblies

ACI SP-66 (2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A951/A951M	(2011) Standard Specification for Steel Wire for Masonry Joint Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1008/A1008M	(2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1064/A1064M	(2017) Standard Specification for

	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C55	(2017) Standard Specification for Concrete Building Brick
ASTM C62	(2017) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C67/C67M	(2020) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C73	(2017) Standard Specification for Calcium Silicate Brick (Sand-Lime Brick)
ASTM C90	(2016) Standard Specification for Loadbearing Concrete Masonry Units
ASTM C129	(2017) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C207	(2018) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C216	(2019) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C270	(2019) Standard Specification for Mortar for Unit Masonry
ASTM C476	(2019) Standard Specification for Grout for Masonry
ASTM C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM C641	(2017) Standard Test Method for Iron Staining Materials in Lightweight Concrete Aggregates
ASTM C780	(2019) Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C1019	(2019) Standard Test Method for Sampling and Testing Grout
ASTM C1384	(2012a) Standard Specification for Admixtures for Masonry Mortars
ASTM C1611/C1611M	(2014) Standard Test Method for Slump Flow of Self-Consolidating Concrete
ASTM C1634	(2011) Standard Specification for Concrete Facing Brick

ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E514/E514M	(2014a) Standard Test Method for Water Penetration and Leakage Through Masonry

THE MASONRY SOCIETY (TMS)

TMS MSJC (2016) Masonry Standard Joint Committee's (MSJC) Book - Building Code Requirements and Specification for Masonry Structures, Containing TMS 402/ACI 530/ASCE 5, TMS 602/ACI 530.1/ASCE 6, and Companion Commentaries

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Cut CMU Drawings; G Reinforcement Detail Drawings; G SD-03 Product Data Hot Weather Procedures; G Cold Weather Procedures; G Clay or Shale Brick; G Glazed Structural Clay Facing Tile; G Glazed Brick; G Salvaged Brick; G Cement; G Cement; G SD-04 Samples Mock-Up Panel; G Clay or Shale Brick; G

Glazed Structural Clay Facing Tile; G

Glazed Brick; G
Concrete Masonry Units (CMU); G
Concrete Brick; G
Dimension Stone Units; G
Admixtures for Masonry Mortar; G
Anchors, Ties, and Bar Positioners; G
Joint Reinforcement; G
Clay Masonry Expansion-Joint Materials; G

SD-05 Design Data

Masonry Compressive Strength; G

Fire-Rated Concrete Masonry Units

Bracing Calculations; G

SD-06 Test Reports

Efflorescence Test Fire-Rated Concrete Masonry Units Field Testing of Mortar

Field Testing of Grout

Prism Tests

Single-Wythe Masonry Wall Water Penetration Test

SD-07 Certificates

Special Masonry Inspector Qualifications Clay or Shale Brick Glazed Structural Clay Facing Tile Glazed Brick Concrete Masonry Units (CMU) Concrete Brick Precast Concrete Units Cementitious Materials Admixtures for Masonry Mortar

Admixtures for Grout Anchors, Ties, and Bar Positioners Joint Reinforcement

SD-08 Manufacturer's Instructions

Admixtures for Masonry Mortar

Admixtures for Grout

SD-10 Operation and Maintenance Data

Take-Back Program

SD-11 Closeout Submittals

Recycled Content of Clay Units; S

Recycled Content of Cement; S

1.3 QUALITY ASSURANCE

1.3.1 Special Masonry Inspector Qualifications

Refer to Section 01 45 35 SPECIAL INSPECTIONS for qualifications and responsibilities of the masonry special inspector.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver, store, handle, and protect material to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1 Masonry Units

Cover and protect masonry units from precipitation. Conform to handling and storage requirements of TMS MSJC.

- a. Pack glazed brick, glazed structural clay tile, and prefaced concrete masonry units in the manufacturer's standard paper cartons, trays, or shrink wrapped pallets with a divider between each unit. Do not stack pallets. Do not remove units from cartons until cartons are placed on scaffolds or in the location where units are to be laid.
- b. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Store steel reinforcing bars, coated anchors, ties, and joint reinforcement above the ground. Maintain steel reinforcing bars and uncoated ties free of loose mill scale and loose rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Deliver cementitious and other packaged materials in unopened containers, plainly marked and labeled with manufacturers' names and brands. Store cementitious material in dry, weathertight enclosures or completely cover. Handle cementitious materials in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination and segregation.

1.5 PROJECT/SITE CONDITIONS

Conform to TMS MSJC for hot and cold weather masonry erection.

1.5.1 Hot Weather Procedures

When ambient air temperature exceeds 100 degrees F, or exceeds 90 degrees F and the wind velocity is greater than 8 mph, comply with TMS MSJC Article 1.8 D for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

1.5.2 Cold Weather Procedures

When ambient temperature is below 40 degrees F, comply with TMS MSJC Article 1.8 C for: preparation prior to conducting masonry work; construction while masonry work is in progress; and protection for newly completed masonry.

- PART 2 PRODUCTS
- 2.1 SYSTEM DESCRIPTION
- 2.1.1 Design Specified Compressive Strength of Masonry

The specified compressive strength of masonry, f'm, is as indicated for each type of masonry .

2.1.2 Performance - Verify Masonry Compressive Strength

Verify specified compressive strength of masonry using the "Unit Strength Method" of TMS MSJC. Submit calculations and certifications of unit and mortar strength.

Verify specified compressive strength of masonry using the "Prism Test Method" of TMS MSJC when the "Unit Strength Method" cannot be used. Submit test results.

2.2 MANUFACTURED UNITS

2.2.1 General Requirements

Do not change the source of materials, which will affect the appearance of the finished work, after the work has started except with Contracting Officer's approval. Submit test reports from an approved independent laboratory. Certify test reports on a previously tested material as the same materials as that proposed for use in this project. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2.2 Clay or Shale Brick

2.2.2.1 General

2.2.2.1.1 Sample Submittal

Submit brick samples as specified, showing the color range and texture of clay or shale brick. Limit units used on the project to those that conform to the approved sample. Submit sample of colored mortar with applicable masonry unit and color samples of three stretcher units and one unit for each type of special shape.

2.2.2.1.2 Uniformity

Deliver clay or shale brick units factory-blended to provide a uniform appearance and color range in the completed wall.

2.2.2.2 Solid Clay or Shale Brick

Provide solid clay or shale brick that conforms to ASTM C216, ASTM C62. Where brick cores, recesses, or deformation would be exposed to view, provide 100 percent solid units. Provide brick with texture and color tange to match the brick on display at EXISTING BUILDING

Provide brick with specified sizes.

a. Modular size, 3-5/8 inches thick, 2-1/4 inches high, and 7-5/8 inches long.

2.2.3 Concrete Units

2.2.3.1 Aggregates

Test lightweight aggregates, and blends of lightweight and heavier aggregates in proportions used in producing the units, for stain-producing iron compounds in accordance with ASTM C641, visual classification method. Do not incorporate aggregates for which the iron stain deposited on the filter paper exceeds the "light stain" classification.

2.2.3.2 Concrete Masonry Units (CMU)

2.2.3.2.1 Cement

Use only cement that has a low alkali content and is of one brand.

2.2.3.2.2 Size

Provide units with specified dimension of 8 inches wide, 8 inches high, and 16 inches long.

2.2.3.2.3 Surfaces

For units that are to be plastered or stuccoed, provide surfaces that are sufficiently rough to provide bond.

2.2.3.2.4 Weather Exposure

Provide concrete masonry units with water-repellant admixture added during

manufacture where units will be exposed to weather.

2.2.3.2.5 Unit Types

- a. Hollow Load-Bearing Units: ASTM C90, lightweight or normal weight. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.
- b. Hollow Non-Load-Bearing Units: ASTM C129, lightweight or normal weight. Load-bearing units may be provided in lieu of non-load-bearing units.
- c. Solid Load-Bearing Units: ASTM C90, lightweight or normal weight units. Provide solid units as indicated.

2.2.3.2.6 Jamb Units

Provide jamb units of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved.

Provide sash jamb units with a 3/4 by 3/4 inch groove near the center at end of each unit.

2.2.3.3 Fire-Rated Concrete Masonry Units

For indicated fire-rated construction, provide concrete masonry units of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated by linear interpolation based on the percent by dry-rodded volume of each aggregate used in manufacturing the units.

TABLE I									
FIRE-RATED CONCRETE MASONRY UNITS									
Aggregate Type	Minimum Equivalent Thickness for Fire-Resistance								
	Rating, inch								
	1/2	3/4	1 hour	1-1/2	2	3 hours	4		
	hour	hour		hour	hours		hours		
Calcareous or siliceous gravel (other than limestone)	2.0	2.4	2.8	3.6	4.2	5.3	6.2		
Limestone, cinders, or air-cooled slag	1.9	2.3	2.7	3.4	4.0	5.0	5.9		
Expanded clay, expanded shale, or expanded slate	1.8	2.2	2.6	3.3	3.6	4.4	5.1		
Expanded slag or pumice	1.5	1.9	2.1	2.7	3.2	4.0	4.7		

Determine equivalent thickness in accordance with ACI 216.1. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; include the thickness of plaster or brick or other material in the assembly in determining the equivalent thickness. Submit calculation

results.

- 2.2.3.4 Concrete Brick
- 2.2.3.4.1 Common Concrete Brick

Provide common concrete brick conforming to $\rm ASTM\ C55$. Common concrete brick may be used where necessary for filling out in concrete masonry unit construction.

2.2.3.4.2 Concrete Brick for Facing

Provide concrete brick for exposed applications that conforms to ASTM C1634. Submit samples as specified.

2.2.3.4.3 Sand-Lime Brick

Provide calcium-silicate (sand-lime) that conforms to ASTM C73, Grade SW, approximately 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long or modular, with smooth surfaces and natural color.

- 2.3 EQUIPMENT
- 2.3.1 Vibrators

Maintain at least one spare vibrator on site at all times.

2.3.2 Grout Pumps

Pumping through aluminum tubes is not permitted.

2.4 MATERIALS

- 2.4.1 Mortar Materials
- 2.4.1.1 Cementitious Materials

Provide cementitious materials that conform to those permitted by ASTM C270.

2.4.1.2 Hydrated Lime and Alternates

Provide lime that conforms to one of the materials permitted by ASTM C207 for use in combination with portland cement, hydraulic cement, and blended hydraulic cement. Do not use lime in combination with masonry cement or mortar cement.

2.4.1.3 Admixtures for Masonry Mortar

In cold weather, use a non-chloride based accelerating admixture that conforms to ASTM C1384, unless Type III portland cement is used in the mortar.

In showers and kitchens, use mortar that contains a water-repellent admixture that conforms to ASTM C1384. Provide a water-repellent admixture, conforming to ASTM C1384 and of the same brand and manufacturer as the block's integral water-repellent, in the mortar used to place concrete masonry units that have an integral water-repellent admixture.

2.4.1.4 Aggregate and Water

Provide aggregate (sand) and water that conform to materials permitted by ASTM C270.

- 2.4.2 Grout and Ready-Mix Grout Materials
- 2.4.2.1 Cementitious Materials for Grout

Provide cementitious materials that conform to those permitted by ASTM C476.

2.4.2.2 Admixtures for Grout

Water-reducing admixtures that conform to ASTM C494/C494M Type F or G and viscosity-modifying admixtures that conform to ASTM C494/C494M Type S are permitted for use in grout. Other admixtures require approval by the Contracting Officer.

In cold weather, a non-chloride based accelerating admixture may be used subject to approval by the Contracting Officer; use accelerating admixture that is non-corrosive and conforms to ASTM C494/C494M, Type C.

2.4.2.3 Aggregate and Water

Provide fine and coarse aggregates and water that conform to materials permitted by ASTM C476.

- 2.5 MORTAR AND GROUT MIXES
- 2.5.1 Mortar Mix
 - a. Provide mortar Type S unless specified otherwise herein. Do not use air-entrainment in the mortar.
 - b. Use ASTM C270 Type S cement-lime mortar or mortar cement mortar for seismic-force-resisting elements indicated.
 - . For field-batched mortar, measure component materials by volume. Use measuring boxes for materials that do not come in packages, such as sand, for consistent batching. Mix cementitious materials and aggregates between 3 and 5 minutes in a mechanical batch mixer with a sufficient amount of water to produce a workable consistency. Do not hand mix mortar unless approved by the Contracting Officer. Maintain workability of mortar by remixing or retempering. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.
 - g. For preblended mortar, follow manufacturer's mixing instructions.
- 2.5.2 Grout and Ready Mix Grout Mix

Use grout that conforms to ASTM C476, fine . Use conventional grout with a slump between 8 and inches. Use self-consolidating grout with slump flow of 24 to 30 inches and a visual stability index (VSI) not greater than 1. Provide minimum grout strength of 2000 psi in 28 days, as tested in accordance with ASTM C1019. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that grout meets the specified requirements. Use ready-mixed grout that conforms to ASTM C476.

2.6 ACCESSORIES

2.6.1 Grout Barriers

Grout barriers for vertical cores that consist of fine mesh wire, fiberglass, or expanded metal.

2.6.2 Anchors, Ties, and Bar Positioners

2.6.2.1 General

- a. Fabricate anchors and ties without drips or crimps. Size anchors and ties to provide a minimum of 5/8 inch mortar cover from each face of masonry.
- b. Fabricate steel wire anchors and ties shall from wire conforming to ASTM A1064/A1064M and hot-dip galvanize in accordance with ASTM A153/A153M.
- c. Fabricate joint reinforcement in conformance with ASTM A951/A951M. Hot dip galvanize joint reinforcement in exterior walls and in interior walls exposed to moist environment in conformance with ASTM A153/A153M. Galvanize joint reinforcement in other interior walls in conformance with ASTM A641/A641M; coordinate with paragraph JOINT REINFORCEMENT below.
- d. Fabricate sheet metal anchors and ties in conformance with ASTM A1008/A1008M. Hot dip galvanize sheet metal anchors and ties in exterior walls and in interior walls exposed to moist environment in compliance with ASTM A153/A153M Class B. Galvanize sheet metal anchors and ties in other interior walls in compliance with ASTM A653/A653M, Coating Designation G60.
- e. Submit two anchors, ties and bar positioners of each type used, as samples.
- 2.6.2.2 Wire Mesh Anchors

Provide wire mesh anchors of 1/4 inch mesh galvanized hardware cloth, conforming to ASTM A185/A185M, with length not less than 12 inches, at intersections of interior non-bearing masonry walls.

2.6.2.3 Veneer Anchor Screws

Provide screws for attachment of veneer anchors to cold-formed steel framing members of size as indicated . Provide length of screws such that the screws penetrate the holding member by not less than 5/8 inch.

2.6.2.4 Bar Positioners

Factory-fabricate bar positioners, used to prevent displacement of reinforcing bars during the course of construction, from 9 gauge steel wire or equivalent, and hot-dip galvanized. Bar positioners must be suitable for intended use and be corrosion resistant steel. Bar positioners not fully contained within the wythe must be hot-dip galvanized.

2.6.3 Joint Reinforcement

Factory fabricate joint reinforcement in conformance with ASTM A951/A951M, welded construction. Provide ladder type joint reinforcement, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units and with all wires a minimum of 9 gauge. Size joint reinforcement to provide a minimum of 5/8 inch cover from each face. Space crosswires not more than 16 inches. Provide joint reinforcement for straight runs in flat sections not less than 10 feet long. Provide joint reinforcement with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features. Submit one piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

2.6.4 Reinforcing Steel Bars

Reinforcing steel bars and rods shall conform to ASTM A615/A615M or ASTM A996/A996M, Grade 60.

2.6.5 Concrete Masonry Control Joint Keys

Provide control joint keys of a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D2000 M2AA-805 with a minimum durometer hardness of 80 or polyvinyl chloride conforming to ASTM D2287 Type PVC 654-4 with a minimum durometer hardness of 85. Form the control joint key with a solid shear section not less than 5/8 inch thick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch, to fit neatly, but without forcing, in masonry unit jamb sash grooves.

2.6.6 Clay Masonry Expansion-Joint Materials

Provide backer rod and sealant, adequate to accommodate joint compression and extension equal to 50 percent of the width of the joint. Provide the backer rod of compressible rod stock of closed cell polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Provide sealant in conformance with Section 07 92 00 JOINT SEALANTS.

Submit one piece of each type of material used.

- 2.6.7 Through Wall Flashing and Weeps
- 2.6.7.1 General

Provide coated copper, copper or stainless steel sheet, self-adhesive rubberized sheet, or reinforced membrane sheet flashing and

2.6.7.2 Coated-Copper Flashing

Provide 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, asphalt impregnated kraft paper or polyethylene sheets.

2.6.7.3 Weep Ventilators

Provide weep ventilators that are prefabricated from stainless steel or

plastic. Provide inserts with grill or louver-type openings designed to allow the passage of moisture from cavities and to prevent the entrance of insects, and with a rectangular closure strip to prevent mortar droppings from clogging the opening. Provide ventilators with compressible flanges to fit in a standard 3/8 inch wide mortar joint and with height equal to the nominal height of the unit.

2.6.7.4 Metal Drip Edge

Provide stainless steel drip edge, 15-mil thick, hemmed edges, with down-turned drip at the outside edge and upturned dam at the inside edge for use with membrane flashings.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to start of work, verify the applicable conditions as set forth in TMS MSJC, inspection.

3.2 PREPARATION

3.2.1 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.2.2 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.2.3 Concrete Surfaces

Where masonry is to be placed, clean concrete of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2.4 Shelf Angles

Adjust shelf angles as required to keep the masonry level and at the proper elevation.

3.2.5 Bracing

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by OSHA and local codes and submit bracing calculations, sealed by a registered professional engineer. Do not remove bracing in less than 10 days.

3.3 ERECTION

3.3.1 General

a. Coordinate masonry work with the work of other trades to accommodate
built-in items and to avoid cutting and patching. Lay masonry units in running bond pattern. Lay facing courses level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances is plus or minus 1/2 inch. Adjust each unit to its final position while mortar is still soft and has plastic consistency.

- b. Remove and clean units that have been disturbed after the mortar has stiffened, and relay with fresh mortar. Keep air spaces, cavities, chases, expansion joints, and spaces to be grouted free from mortar and other debris. Select units to be used in exposed masonry surfaces from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work.
- c. When necessary to temporarily discontinue the work, step (rack) back the masonry for joining when work resumes. Toothing may be used only when specifically approved by the Contracting Officer. Before resuming work, remove loose mortar and thoroughly clean the exposed joint. Cover the top of walls subjected to rain or snow with nonstaining waterproof covering or membrane when work is not in process. Extend the covering a minimum of 610 mm 2 feet down on each side of the wall and hold securely in place.
- d. Ensure that units being laid and surfaces to receive units are free of water film and frost. Lay solid units in a nonfurrowed full bed of mortar. Bevel mortar for veneer wythes and slope down toward the cavity side. Shove units into place so that the vertical joints are tight. Completely fill vertical joints between solid units with mortar, except where indicated at control, expansion, and isolation joints. Place hollow units so that mortar extends to the depth of the face shell at heads and beds, unless otherwise indicated. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Provide means to prevent mortar from dropping into the space below or clean grout spaces prior to grouting.
- e. In multi-wythe construction with collar joints no more than 3/4 inch wide, bring up the inner wythe not more than 16 inches ahead of the outer wythe. Fill collar joints with mortar during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by back-buttering each unit as it is laid.

3.3.1.1 Jointing

Tool mortar joints when the mortar is thumbprint hard. Tool horizontal joints after tooling vertical joints. Brush mortar joints to remove loose and excess mortar.

3.3.1.1.1 Tooled Joints

Tool mortar joints in exposed exterior and interior masonry surfaces concave , using a jointer that is slightly larger than the joint width so that complete contact is made along the edges of the unit. Perform tooling so that the mortar is compressed and the joint surface is sealed. Use a jointer of sufficient length to obtain a straight and true mortar joint. No exterior joints are to be left un-tooled.

3.3.1.1.2 Flush Joints

Flush cut mortar joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas. Finish flush cut joints by cutting

off the mortar flush with the face of the wall. Point joints in unparged masonry walls below grade tight. For architectural units, such as fluted units, completely fill both the head and bed joints and flush cut.

3.3.1.1.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.3.1.1.4 Joint Widths

- a. Construct brick masonry with mortar joint widths equal to the difference between the specified and nominal dimensions of the unit, within tolerances permitted by TMS MSJC.
- b. Provide 3/8 inch wide mortar joints in concrete masonry, except for prefaced concrete masonry units.
- c. Provide 3/8 inch wide mortar joints on unfaced side of prefaced concrete masonry units and not less than 3/16 inch nor more than 1/4 inch wide on prefaced side.
- d. Maintain mortar joint widths within tolerances permitted by TMS MSJC

3.3.1.2 Cutting and Fitting

Use full units of the proper size wherever possible, in lieu of cut units. Locate cut units where they would have the least impact on the architectural aesthetic goals of the facility. Perform cutting and fitting, including that required to accommodate the work of others, by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Before being placed in the work, dry wet-cut units to the same surface-dry appearance as uncut units being laid in the wall. Provide cut edges that are clean, true and sharp.

- a. Carefully make openings in the masonry so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Provide reinforced masonry lintels above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.
- b. Do not reduce masonry units in size by more than one-third in height and one-half in length. Do not locate cut products at ends of walls, corners, and other openings.

3.3.1.3 Unfinished Work

Rack back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved by the Contracting Officer. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.3.1.4 Control Joints

Provide control joints in concrete masonry as indicated. Construct by using special control-joint units in accordance with the details shown on the

Drawings. Form a continuous vertical joint at control joint locations, including through bond beams, by utilizing half blocks in alternating courses on each side of the joint. Interrupt the control joint key in courses containing continuous bond beam reinforcement. Do not interrupt the horizontal reinforcement and grout at the control joint.

Where mortar was placed in the joint, rake both faces of the control joints to a depth of 3/4 inch. Install backer rod and sealant on both faces in accordance with Section 07 92 00 JOINT SEALANTS.

3.3.1.5 Decorative Architectural Units

Place decorative masonry units with the patterned face shell properly aligned in the completed wall.

3.3.2 Clay or Shale Brick Masonry

3.3.2.1 Brick Placement

Blend all brick at the jobsite from several cubes to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable. Lay brick facing with the better face exposed. Lay brick in running bond with each course bonded at corners, unless otherwise indicated. Lay molded brick with the frog side down. Do not lay brick that is cored, recessed, or has other deformations in a manner that allows those deformations to be exposed to view; lay 100 percent solid units in these areas. Completely fill head and bed joints of solid units with mortar. Lay hollow units with mortar joints as specified for concrete masonry units.

Place exterior face of salvaged bricks towards the exterior.

3.3.2.2 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C67/C67M. Ensure that each unit is nearly saturated when wetted but surface dry when laid.

Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.3.2.3 Brick Sills

Lay brick on edge, slope not less than 3/4 inch downward to the outside, and project not less than 1/2 inch beyond the face of the wall to form a wash and drip. Fill all joints solidly with mortar and tool.

3.3.3 Anchored Veneer Construction

a. Construct exterior masonry wythes to the thickness indicated on the drawings. Provide a minimum 2" inch air space behind the masonry veneer. Provide means to ensure that the cavity space and flashings are kept clean of mortar droppings and other loose debris. Maintain chases and raked-out joints free from mortar and debris.

- b. Place masonry in running bond pattern.
- c. For veneer over stud framing, do not install veneer until the exterior sheathing, moisture barrier, veneer anchors and flashing have been installed on the backing. Take extreme care to avoid damage to the moisture barrier and flashing during construction of the masonry veneer. Repair or replace portions of the moisture barrier and flashing that are damaged prior to completion of the veneer. Provide a continuous cavity as indicated.
- d. For veneer with a masonry backup wythe, lay up both the inner and the outer wythes together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, install through-wall flashings with the exterior wythe, securing the top edge of the flashing with a termination bar and sealant, or protect flashings that are installed with the interior wythe from damage until they are fully enclosed in the wall.
- e. Provide anchors (ties) to connect the veneer to its backing in sufficient quantity to comply with the following requirements: maximum wall area per anchor {tie) of 4, and maximum vertical spacing of 16, and maximum horizontal spacing of 24. Provide additional anchors around openings larger than 16 inch in either direction. Space anchors around perimeter of opening at a maximum of 24 inches on center. Place anchors within 12 inches of openings. Anchors with drips are not permitted.
- f. With solid units, embed anchors in mortar joint and extend into the veneer a minimum of 1-1/2 inch, with at least 5/8 inch mortar cover to the outside face.
- g. With hollow units, embed anchors in mortar or grout and extend into the veneer a minimum of 1-1/2 inch, with at least 5/8 inch mortar or grout cover to outside face.

3.3.4 ANCHORAGE

3.3.4.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 16 inches on centers vertically and 24 inches on center horizontally.

3.3.4.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.3.4.3 Anchorage at Intersecting Walls

Provide wire mesh anchors at maximum 16 inches spacing at intersections of interior non-bearing masonry walls.

Anchor structural masonry walls with strap anchors of minimum size 1/4 inch x 1-1/2 inch x 28 inches including 2 inch) 90 degree bends at each end to form U or Z shape at maximum spacing 48 inches, grouted into the wall, unless the drawings indicate a movement joint at the intersection.

3.3.5 Lintels

3.3.5.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated. Extend lintel reinforcement beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Support reinforcing bars in place prior to grouting and locate 1/2 inch above the bottom inside surface of the lintel unit.

3.3.5.2 Precast Concrete and Steel Lintels

Provide precast concrete and steel lintels as shown on the Drawings. Set lintels in a full bed of mortar with faces plumb and true. Provide steel and precast lintels with a minimum bearing length of 8 inches unless otherwise indicated. In partially grouted masonry, provide fully grouted units under the full lintel bearing length, unless otherwise indicated.

3.3.6 Sills and Copings

Set sills and copings in a full bed of mortar with faces plumb and true. Slope sills and copings to drain water. Mechanically anchor copings and sills longer than 4 feet as indicated.

3.4 INSTALLATION

- 3.4.1 Bar Reinforcement Installation
- 3.4.1.1 Preparation

Submit detail drawings showing bar splice locations. Identify bent bars on a bending diagram and reference and locate such bars on the drawings. Show wall dimensions, bar clearances, and wall openings. Utilize bending details that conform to the requirements of ACI SP-66. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, resubmit the approved shop drawings with the additional openings shown along with the proposed changes. Clearly highlight location of these additional openings. Provide wall elevation drawings with minimum scale of 1/4 inch per foot. Submit drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings.

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, and other coatings that might destroy or reduce its bond prior to placing grout. Do not use bars with kinks or bends not shown on the approved shop drawings. Place reinforcement prior to grouting. Unless otherwise indicated, extend vertical wall reinforcement to within 2 inches of tops of walls.

3.4.1.2 Positioning Bars

a. Accurately place vertical bars within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Provide minimum clearance between parallel bars of 1/2 inch between the bars and masonry units for coarse grout and a minimum clearance of 1/4 inch between the bars and masonry units for fine grout. Provide minimum clearance between parallel bars of 1 inch or one diameter of the reinforcement, whichever is greater. Vertical reinforcement may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement or by other means to prevent displacement beyond permitted tolerances. As masonry work progresses, secure vertical reinforcement to prevent displacement beyond allowable tolerances.

- b. Wire column and pilaster lateral ties in position around the vertical reinforcing bars. Place lateral ties in contact with the vertical reinforcement and do not place in horizontal mortar bed joints.
- c. Position horizontal reinforcing bars as indicated. Stagger splices in adjacent horizontal bars, unless otherwise indicated.
- d. Form splices by lapping bars as indicated. Do not cut, bend or eliminate reinforcing bars. Foundation dowel bars may be field-bent when permitted by TMS MSJC.
- 3.4.1.3 Splices of Bar Reinforcement

Lap splice reinforcing bars as indicated. When used, provide welded or mechanical connections that develop at least 125 percent of the specified yield strength of the reinforcement.

- 3.4.2 Placing Grout
- 3.4.2.1 General

Fill cells containing reinforcing bars with grout. Solidly grout hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces. Solidly grout cells under lintel bearings on each side of openings for full height of openings. Solidly grout walls below grade, lintels, and bond beams. Units other than open end units may require grouting each course to preclude voids in the units.

Discard site-mixed grout that is not placed within 1-1/2 hours after water is first added to the batch or when the specified slump is not met without adding water after initial mixing. Discard ready-mixed grout that does not meet the specified slump without adding water other than water that was added at the time of initial discharge. Allow sufficient time between grout lifts to preclude displacement or cracking of face shells of masonry units. Provide a grout shear key between lifts when grouting is delayed and the lower lift loses plasticity. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, tear down the wall and rebuild.

3.4.2.2 Vertical Grout Barriers for Multi-Wythe Composite Walls

In multi-wythe composite walls, provide grout barriers in the collar join not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.4.2.3 Horizontal Grout Barriers

Embed horizontal grout barriers in mortar below cells of hollow units receiving grout.

3.4.2.4 Grout Holes and Cleanouts

3.4.2.4.1 Grout Holes

Provide grouting holes in slabs, spandrel beams, and other in-place overhead construction. Locate holes over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Provide additional openings spaced not more than 16 inches on centers where grouting of hollow unit masonry is indicated. Fom such openings not less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, plug and finish grouting holes to match surrounding surfaces.

3.4.2.4.2 Cleanouts for Hollow Unit Masonry Construction

For hollow masonry units. provide cleanout holes at the bottom of every grout pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet 4 inches. Where all cells are to be grouted, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout.

Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Provide cleanouts not less than 3 by 3 inch by cutting openings in one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Do not cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.4.2.4.3 Cleanouts for Multi-Wythe Composite Masonry Construction

Provide cleanouts for construction of walls that incorporate a grout filled cavity between solid masonry wythes, provide cleanouts at the bottom of every pour by omitting every other masonry unit from one wythe. Establish a new series of cleanouts if grouting operations are stopped for more than 4 hours. Do not plug cleanout holes until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, close cleanout holes in an approved manner to match surrounding masonry.

3.4.2.5 Grout Placement

A grout pour is the total height of masonry to be grouted prior to erection of additional masonry. A grout lift is an increment of grout placement within a grout pour. A grout pour is filled by one or more lifts of grout.

a. Lay masonry to the top of a pour permitted by TMS MSJC Table 7, based on the size of the grout space and the type of grout. Prior to grouting, remove masonry protrusions that extend 1/2 inch or more into cells or spaces to be grouted. Provide grout holes and cleanouts in accordance with paragraph GROUT HOLES AND CLEANOUTS above when the grout pour height exceeds 5 feet 4 inches. Hold reinforcement, bolts, and embedded connections rigidly in position before grouting is

started. Do not prewet concrete masonry units.

- b. Place grout using a hand bucket, concrete hopper, or grout pump to fill the grout space without segregation of aggregate. Operate grout pumps to produce a continuous stream of grout without air pockets, segregation, or contamination.
- c. If the masonry has cured at least 4 hours, grout slump is maintained between 10 to 11 inches, and no intermediate reinforced bond beams are placed between the top and bottom of the pour height, place conventional grout in lifts not exceeding 12 feet 8 inches. For the same curing and slump conditions but with intermediate bond beams, limit conventional grout lift to the bottom of the lowest bond beam that is more than 5 feet 4 inches above the bottom of the lift, but do not exceed 12 feet 8 inches. If masonry has not cured at least 4 hours or grout slump is not maintained between 10 to 11 inches, place conventional grout in lifts not exceeding 5 feet 4 inches.
- d. Consolidate conventional grout lift and reconsolidate after initial settlement before placing next lift. For grout pours that are 12 inches or less in height, consolidate and reconsolidate grout by mechanical vibration or puddling. For grout pours that are greater than 12 inches in height, consolidate and reconsolidate grout by mechanical vibration. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation. If previous lift is not permitted to set, dip vibrator into previous lift. Do not insert vibrators into lower lifts that are in a semi-solidified state. If lower lift sets prior to placement of subsequent lift, form a grout key by terminating grout a minimum of 1-1/2 inch below a mortar joint. Vibrate each vertical cell containing reinforcement in partially grouted masonry. Do not form grout keys within beams.
- e. If the masonry has cured 4 hours, place self-consolidating grout (SCG) in lifts not exceeding the pour height. If masonry has not cured for at least 4 hours, place SCG in lifts not exceeding 5 feet 4 inches. Do not mechanically consolidate self-consolidating grout. Place self-consolidating grout in accordance with manufacturer's recommendations.
- f. Upon completion of each day's grouting, remove waste materials and debris from the equipment, and dispose of outside the masonry.

3.4.3 Joint Reinforcement Installation

Install joint reinforcement at 16 inches on center unless otherwise indicated. Lap joint reinforcement not less than 6 inches. Install prefabricated sections at corners and wall intersections. Place the longitudinal wires of joint reinforcement in mortar beds to provide not less than 5/8 inch cover to either face of the unit.

3.4.4 Bond Beams

Reinforce and grout bond beams as indicated and as described in paragraphs above. Install grout barriers under bond beam units to retain the grout as required, unless wall is fully grouted or solid bottom units are used. For high lift grouting in partially grouted masonry, provide grout retaining material on the top of bond beams to prevent upward flow of grout. Ensure

that reinforcement is continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated.

- 3.4.5 Flashing and Weeps
 - a. Install through-wall flashing at obstructions in the cavity and where indicated on Drawings. Ensure continuity of the flashing at laps and inside and outside corners by splicing in a manner approved by the flashing manufacturer. Ensure that the top edge of the flashing is sealed by securing the sheet metal flashing into a reglet cast into the concrete backup. Terminate the horizontal leg of the flashing extending the fabric flashing beyond the outside face of masonry and, when construction is complete, cutting the flashing flush with the face of masonry. Provide sealant below the drip edge of through-wall flashing.
 - b. Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated. Provide weeps of weep ventilators. Locate weeps not more than 24 inches on centers in mortar joints of the exterior wythe directly on the horizontal leg of through-wall flashing over foundations, bond beams, and any other horizontal interruptions of the cavity. Place weep holes perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Other methods may be used for providing weeps when spacing is reduced to 16 inches on center and approved by the Contracting Officer. Maintain weeps free of mortar and other obstructions.
 - c. Install single-wythe CMU flashing system in bed joints of CMU walls where CMU cells are open. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall on the exterior side. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

3.5 APPLICATION

3.5.1 Insulation

Insulate cavity walls (multi-wythe noncomposite masonry walls), where shown, by installing board-type insulation on the cavity side of the inner wythe. Apply board type insulation directly to the masonry or thru-wall flashing with adhesive. Neatly fit insulation between obstructions without impaling insulation on ties or anchors. Apply insulation in parallel courses with vertical joints breaking midway over the course below and in moderate contact with adjoining units without forcing. Cut to fit neatly against adjoining surfaces. Tape or seal the joints between the boards.

3.5.2 Interface with Other Products

3.5.2.1 Built-In Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout, unless otherwise indicated.

3.5.2.2 Door and Window Frame Joints

On the exposed interior and exterior sides of exterior frames, rake joints between frames and abutting masonry walls to a depth of 3/8 inch.

3.5.2.3 Bearing Plates

Set bearing plates for beams, joists, joist girders and similar structural members to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Provide bedding mortar and non-shrink grout s specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5.3 Tolerances

Lay masonry plumb, true to line, with courses level within the tolerances of TMS MSJC, Article 3.3 F.

- 3.6 FIELD QUALITY CONTROL
- 3.6.1 Tests

3.6.1.1 Field Testing of Mortar

Perform mortar testing at the following frequency: 1 times per WEEK. For each required mortar test, provide a minimum of three mortar samples. Perform initial mortar testing prior to construction for comparison purposes during construction.

Prepare and test mortar samples for mortar aggregate ratio in accordance with ASTM C780 Appendix A4. Prepare and test mortar compressive strength specimens in accordance with ASTM C780 Appendix A6.

3.6.1.2 Field Testing of Grout

- a. Perform grout testing at the following frequency: 1 times per 50 YARDS OR DAY OF PLACEMENT. For each required grout property to be evaluated, provide a minimum of three specimens.
- b. Sample and test conventional and self-conslidating grout for compressive strength and temperature in accordance with ASTM C1019.
- c. Evaluate slump in conventional grout in accordance with ASTM C1019.
- d. Evaluate slump flow and visual stability index of self-consolidating grout in accordance with ASTM C1611/C1611M.

3.6.1.3 Single-Wythe Masonry Wall Water Penetration Test

Prior to start of field construction of the single-wythe concrete masonry wall, perform masonry wall water penetration test on mock-up wall assemblies consisting of the identical design, materials, mix, and construction methods as the actual wall construction and in accordance with ASTM E514/E514M. Prepare a minimum of three specimens and cure for minimum 28 days prior to testing. Construct panels by the same methods, processes, and applications to be used on the project's construction site. Spray test for 6 hours on each specimen. If water is visible on back of test panels during the test and areas of dampness on the backside of the test panels do not exceed 25 percent of the wall area, the panels will be considered to

have passed. Dampness is defined as any area of surface darkening or discoloration due to moisture penetration or accumulation below the observed surface.

Construct additional test panels for each failed test performed until three test panels pass the test. Factors that can affect test performance include materials, mixing, and quality of application and workmanship. Materials, mixing, and methods adjustments may be necessary in order to provide construction that passes the water penetration test. Document and record the test specimen construction materials and application and provide written test report in accordance with ASTM E514/E514M, supplemented by a detailed discussion of the specifics of test panel construction, application methods and processes used, quality of construction, and any variances or deviations that may have occurred between test panels during test panel construction. For failed test panels, identify in the supplemental report the variances, deficiencies or flaws that contributed to test panel failure and itemize the precautions to be taken in field construction of the masonry wall to prevent similar deficiencies and assure the wall construction replicates test panel conditions that pass the water penetration test. Submit the complete, certified test report, including supplemental report, to the Contracting Officer prior to start of single-wythe concrete masonry wall construction. Significant changes to materials, proportions, or construction techniques from those used in the passing water penetration test are grounds for performing new tests, at the discretion of the Contracting Officer.

3.6.2 Special Inspection

Perform special inspections and testing in accordance with Section 01 $45\ 35$ SPECIAL INSPECTIONS.

3.7 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs and splashings from masonry-unit surfaces that will be exposed or painted. Before completion of the work, rake out defects in joints of masonry to be exposed or painted, fill with mortar, and tool to match existing joints. Immediately after grout work is completed, remove scum and stains that have percolated through the masonry work using a low pressure stream of water and a stiff bristled brush. Do not clean masonry surfaces, other than removing excess surface mortar, until mortar in joints has hardened. Leave masonry surfaces clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Do not use metal tools and metal brushes for cleaning.

3.7.1 Dry-Brushing Concrete Masonry

Dry brush exposed concrete masonry surfaces at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.7.2 Clay Brick Surfaces

Clean exposed clay brick masonry surfaces to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. Perform cleaning in accordance with the approved cleaning procedure demonstrated on the mockup.

After cleaning, examine the sample panel of similar material for

discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, change the method of cleaning to ensure that the masonry surfaces in the structure will not be adversely affected. Water-soak exposed masonry surfaces and then clean with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay brick manufacturer and manufacturer of the cleaning product. Apply the solution with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Use proprietary cleaning agents in conformance with the cleaning product manufacturer's printed recommendations. Remove efflorescence in conformance with the brick manufacturer's recommendations.

3.8 CLOSE-OUT TAKE-BACK PROGRAM

Collect information from manufacturer for take-back program options. Set aside to be returned to manufacturer for recycling into new product. When such a service is not available, seek local recyclers to reclaim the materials. Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

3.9 PROTECTION

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane to protect from moisture intrusion when work is not in progress. Continue covering the top of the unfinished walls until the wall is waterproofed with a complete roof or parapet system. Extend covering a minimum of 2 feet down on each side of the wall and hold securely in place. Before starting or resuming work, clean top surface of masonry in place of loose mortar and foreign material.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL 05/14

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2011; Errata 1 2012; Errata 2 2013; Errata 3 2015) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2012) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings

ASTM INTERNATIONAL (ASTM)

ASTM	A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM	A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM	A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM	A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM	A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM	F2329	(2013) Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM	F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2013;	with	Change	1)	Structural
	Engine	ering			

UFC 3-310-04 (2013) Seismic Design for Buildings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings Including Description of Connections; G

SD-06 Test Reports

Bolts, Nuts, And Washers

SD-07 Certificates

Steel

Galvanizing

AISC Fabrication Plant Quality Certification

1.3 AISC QUALITY CERTIFICATION

Work must be fabricated in an AISC Certified Fabrication Plant, Category Std. Submit AISC fabrication plant quality certification.

1.4 SEISMIC PROVISIONS

The structural steel system must be provided in accordance with AISC 341, Chapter J as amended by UFC 3-310-04.

1.5 QUALITY ASSURANCE

1.5.1 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the structural steel system, including galvanizing, complete and ready for use. Structural steel including materials, fabrication, inspection, quality control, and testing must be provided in accordance with AISC 360, AISC 341, UFC 3-301-01 and UFC 3-310-04 except as modified in this contract.

- 2.2 STEEL
- 2.2.1 Structural Steel

Angles, Channels and Plates, ASTM A36/A36M.

2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

- 2.3.1 Common Grade Bolts
- 2.3.1.1 Bolts

ASTM A307, Grade A. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.3.1.2 Nuts

ASTM A563M, Grade A, heavy hex style.

2.3.1.3 Washers

ASTM F844.

2.4 GALVANIZING

ASTM F2329 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.5 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the greatest extent possible. Punch, subpunch and ream, or drill bolt and pin holes perpendicular to the surface of the member.

2.5.1 Markings

Prior to erection, members must be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections must be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

- PART 3 EXECUTION
- 3.1 ERECTION
 - a. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325.

3.1.1 STORAGE

Material must be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, connections not detailed must be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

3.2.1 Common Grade Bolts

ASTM A307 bolts must be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.3 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.4 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.5 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. The Contracting Officer must be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of the inspection.

-- End of Section --

SECTION 05 52 00

METAL RAILINGS 02/18

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 314	(1990;	R 2	013)	Standard	Specification	for
	Steel	Anch	or Bo	olts		

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2020) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M (2017) Standard Specification for Steel Castings, Carbon, for General Application (2014) Standard Specification for Carbon ASTM A36/A36M Structural Steel ASTM A47/A47M (1999; R 2018; E 2018) Standard Specification for Ferritic Malleable Iron Castings ASTM A53/A53M (2018) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless ASTM A108 (2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished (2017) Standard Specification for Zinc ASTM A123/A123M (Hot-Dip Galvanized) Coatings on Iron and Steel Products ASTM A153/A153M (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware ASTM A283/A283M (2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates (2014; E 2017) Standard Specification for ASTM A307 Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM A500/A500M	(2018) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C514	(2004; R 2014) Standard Specification for Nails for the Application of Gypsum Board
ASTM E488/E488M	(2015) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521 (2001; R 2012) Pipe Railing Systems Manual

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

Within 30 days of contract award, submit fabrication drawings to the Contracting Officer for the following items:

- c. Steel railings and handrails
- e. Anchorage and fastening systems

Submit manufacturer's catalog data, including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

- a. Structural-steel plates, shapes, and bars
- b. Structural-steel tubing
- c. Cold-finished steel bars
- d. Hot-rolled carbon steel bars
- e. Cold-drawn steel tubing
- f. Concrete inserts
- g. Masonry anchorage devices
- h. Protective coating
- i. Steel railings and handrails

- j. Aluminum railings and handrails
- k. Anchorage and fastening systems

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars and Strips; G

SD-03 Product Data

Structural-Steel Plates, Shapes, and Bars; G

Structural-Steel Tubing; G

Cold-Finished Steel Bars; G

Hot-Rolled Carbon Steel Bars; G

Cold-Drawn Steel Tubing; G

Concrete Inserts; G

Masonry Anchorage Devices; G

Protective Coating; G

Steel Railings and Handrails; G

Aluminum Railings and Handrails; G

Anchorage and Fastening Systems; G

SD-07 Certificates

Welding Procedures; G

Welder Qualification; G

SD-08 Manufacturer's Instructions

Installation Instructions

1.4 QUALITY CONTROL

1.4.1 Welding Procedures

Submit results of welding procedures testing in accordance with

AWS D1.1/D1.1M made in the presence of the Contracting Officer and by an approved testing laboratory at the Contractor's expense.

1.4.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

PART 2 PRODUCTS

2.1 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail detail plans and elevations at not less than 1 inch to 1 foot. Provide details of sections and connections at not less than 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and straight sharp edges. Ensure that all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form the exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use countersunk Phillips flathead screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.1.1 Aluminum Railings

Fabrication: Provide fabrication jointing by one of the following methods:

- a. Use flush-type rail fittings, welded and ground smooth with splice locks secured with 3/8 inch recessed-head set screws.
- b. Ensure that mitered and welded joints made by fitting; post to top rail; intermediate rail to post; and corners, are groove welded and ground smooth. Where allowed by the Contracting Officer, provide butt splices reinforced by a tight-fitting dowel or sleeve not less than 6 inches in length. Tack-weld or epoxy-cement the dowel or sleeve to one side of the splice.
- c. Assemble railings using slip-on aluminum-magnesium alloy fittings for joints. Fasten fittings to pipe or tube with 1/4 or 3/8 inch stainless-steel recessed-head setscrews. Provide assembled railings with fittings only at vertical supports or at rail terminations attached to walls. Provide expansion joints at the midpoint of panels. Provide a setscrew in only one side of the slip-on sleeve. Provide alloy fittings to conform to ASTM B26/B26M.

2.1.2 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

- a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.
- b. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove-welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight-fitting interior sleeve not less than 6 inches long.
- c. Railings may be bent at corners in lieu of jointing, provided that bends are made in suitable jigs and the pipe is not crushed.

2.1.3 Protective Coating

Provide hot-dipped galvanized steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

2.2 COMPONENTS

2.2.1 Structural Steel Plates, Shapes And Bars

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.2.2 Structural-Steel Tubing

Provide structural-steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.2.3 Hot-Rolled Carbon Steel Bars

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

2.2.4 Cold-Finished Steel Bars

Provide cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.2.5 Cold-Drawn Steel Tubing

Provide tubing conforming to ASTM A512, sunk-drawn, butt-welded, cold-finished, and stress-relieved.

2.2.6 Steel Pipe

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.2.7 Concrete Inserts

Provide threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4 inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

2.2.8 Masonry Anchorage Devices

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488/E488M and ASTM C514 as follows:

Provide bolt anchor expansion shields for bolts; closed-end bottom-bearing class, Group II, Type 2, Class 1.

2.2.9 Fasteners

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide standard hexagon-head bolts, conforming to ASTM A307, Grade A.

2.2.10 Steel Railings And Handrails

Design handrails to resist a concentrated load of 200 lb in any direction at any point of the top of the rail or 50 lb per foot applied horizontally to the top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and

finish as the handrail and posts. Provide series 300 stainless-steel pipe collars.

2.2.10.1 Steel Handrails

Provide steel handrails, including inserts in concrete, structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength. Provide steel railings of 2 inch nominal size, hot-dip galvanized .

Provide kickplates between railing posts where indicated, and consisting of 1/8 inch steel flat bars not less than 6 inches high. Secure kickplates as indicated.

Galvanize exterior railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components. Provide black steel pipe for interior railings.

PART 3 EXECUTION

3.1 PREPARATION

Adjust stair railings and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 5 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

a. Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard-weight, steel pipe, not less than 6 inches long, and having an inside diameter not less than 1/2 inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 1 inch greater than the outside diameter of the sleeve, with the annular space between the post and sleeve with nonshrink grout ora quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 3 inch projection from the finished wall surface to the center of the pipe, drilled to receive one 3/8 inch bolt. Locate brackets not more than 60 inches on center. Provide wall return fittings of cast iron castings, flush type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

a. For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

Install toe boards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

3.2 INSTALLATION

Submit manufacturer's installation instructions for the following products to be used in the fabrication of steel :

a. Structural-steel plates, shapes, and bars

- b. Structural-steel tubing
- c. Cold-finished steel bars
- d. Hot-rolled carbon steel bars
- e. Cold-drawn steel tubing
- f. Protective coating
- g. Masonry anchorage devices
- h. Steel railings and handrails
- i. Aluminum railings and handrails
- j. Anchorage and fastening systems

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars, and strips used in accordance with the design specifications cited in this section.

3.2.1 Steel Handrail

Install handrail in pipe sleeves embedded in concrete and filled with nonshrink grout or quick-setting anchoring cement with anchorage covered with standard pipe collar pinned to post. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY 08/16

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC 111	(2005) Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection
AITC TCM	(2012) Timber Construction Manual, 5th Edition

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20	(2015)	American	Softwood	Lumber	Standard
	/				

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012;	Errata	a 2013)	Square	and	Hex	Bolts
	and Sc	rews (]	Inch Se	ries)			

ASME B18.2.2 (2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B18.5.2.1M (2006; R 2011) Metric Round Head Short Square Neck Bolts

ASME B18.5.2.2M (1982; R 2010) Metric Round Head Square Neck Bolts

ASME B18.6.1 (2016) Wood Screws (Inch Series)

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2015) National Design Specification (NDS)
	for Wood Construction
	(2012) March Europe Grantworthing Manual Fra

AWC WFCM (2012) Wood Frame Construction Manual for One- and Two-Family Dwellings

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2 (2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use

AWPA M6 (2013) Brands Used on Preservative Treated

Materials

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA	EWS	R540	(2013) Builder Tips: Proper Storage and Handling of Glulam Beams
APA	EWS	Т300	(2007) Technical Note: Glulam Connection

Details

ASTM INTERNATIONAL (ASTM)

- ASTM A153/A153M (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A653/A653M (2019) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- ASTM C1136 (2017a) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
- ASTM D2898 (2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
- ASTM E96/E96M (2016) Standard Test Methods for Water Vapor Transmission of Materials
- ASTM F547 (2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2018) International Building Code

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules (2015) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules (2013) Standard Grading Rules for Northeastern Lumber

REDWOOD INSPECTION SERVICE (RIS) OF THE CALIFORNIA REDWOOD ASSOCIATION (CRA)

RIS Grade Use (1998) Redwood Lumber Grades and Uses

SOUTHERN CYPRESS MANUFACTURERS ASSOCIATION (SCMA)

SCMA Spec(1986; Supple. No. 1, Aug 1993) StandardSpecifications for Grades of Southern

Cypress

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003 (2014) Standard Grading Rules for Southern Pine Lumber

TRUSS PLATE INSTITUTE (TPI)

TPI 1(2014) National Design Standard for MetalPlate Connected Wood Truss Construction,Including Commentary and Appendices

UNDERWRITERS LABORATORIES (UL)

UL 2818 (2013) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17 (2015) Standard Grading Rules

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5 (2017) Western Lumber Grading Rules

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Structural Glued Laminated Members; G

Trussed Rafters; G

Trussed Joists; G

Fabricated Structural Members; G

Modifications of Structural Members; G

Drawings of structural laminated members, fabricated wood trusses, engineered wood joists and rafters, and other fabricated structural members indicating materials, shop fabrication, and field erection details; including methods of fastening.

Nailers and Nailing Strips; G

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications. SD-03 Product Data

Underlayment

Plastic Lumber

Fiberboard Wall Sheathing

Cellulose Honeycomb Panels

Fire-retardant Treatment

Structural-use and OSB Panels

Oriented Strand Board

Adhesives

Biobased Content for Strawboard Panels; S

Biobased Content for Cork Underlayment; S

Recycled Content for Plastic Lumber; S

Recycled Content for Fiberboard Underlayment; S

Recycled Content for Cork Underlayment; S

Recycled Content for Fiberboard Wall Sheathing; S

Recycled Content for Cellulose Honeycomb Panels; S

SD-05 Design Data

Modifications of Structural Members; G

Design analysis and calculations showing design criteria used to accomplish the applicable analysis.

SD-06 Test Reports

Preservative-treated Lumber and Plywood

SD-07 Certificates

Certificates of Grade Preservative Treatment Indoor Air Quality for Particleboard Underlayment; S Indoor Air Quality for Fiberboard Underlayment; S Indoor Air Quality for Strawboard Panels; S Indoor Air Quality for Fiberboard Wall Sheathing; S Indoor Air Quality for Aerosol Adhesives; S Indoor Air Quality for Non-aerosol Adhesives; S

SD-10 Operation and Maintenance Data

Take-back Program

Include contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling or reuse.

1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Store wood I-beams and glue-laminated beams and joists on edge. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Handle and store laminated timber in accordance with AITC 111 or APA EWS R540. Do not use materials that have visible moisture or biological growth. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view must not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Preservative-Treated Lumber and Plywood

The Contractor is responsible for the quality of treated wood products. Each treated piece must be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor must provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.5 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber must be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes must be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products must be as follows at the time of delivery to the job site:

- a. Framing lumber and board, 19 percent maximum
- b. Timbers 5 inches and thicker, 25 percent maximum
- d. Materials other than lumber; moisture content must be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

- a. 0.25 pcf intended for above ground use.
- b. 0.40 pcf intended for ground contact and fresh water use. 0.60 pcf intended for Ammoniacal Copper Quaternary Compound (ACQ)-treated foundations. 0.80 to 1.00 pcf intended for ACQ-treated pilings. All wood must be air or kiln dried after treatment. Specific treatments must be verified by the report of an approved independent inspection agency, or the AWPA Quality Mark on each piece. Brush coat areas that are cut or drilled after treatment with either the same preservative used in the treatment or with a 2 percent copper naphthenate solution. All lumber and woodwork must be preservative treated. Plastic lumber must not be preservative treated. The following items must be preservative treated:
 - (1) Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 24 inches or less from the earth underneath.
 - (2) Wood members that are in contact with water.
 - (3) Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.
 - (4) Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.
 - (5) Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.8 FIRE-RETARDANT TREATMENT

Fire-retardant treated wood must be pressure treated Treatment and performance inspection must be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material must bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting must be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, must receive exterior fire-retardant treatment. Fire-retardant-treated wood products must be free of halogens, sulfates, ammonium phosphate, and formaldehyde. Items to be treated include the following:

a. .

1.9 QUALITY ASSURANCE

1.9.1 Drawing Requirements

For fabricated structural members, trusses, qlu-lam members, indicate materials, details of construction, methods of fastening, and erection details. Include reference to design criteria used and manufacturers design calculations. Submit drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

1.9.2 Data Required

Submit calculations and drawings for all proposed modifications of structural members. Do not proceed with modifications until the submittal has been approved.

- 1.10 CERTIFICATIONS
- 1.10.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

1.10.2 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package. 1.10.2.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

PART 2 PRODUCTS

- 2.1 MATERIALS
- 2.1.1 Virgin Lumber

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible. Provide certified sustainably harvested virgin lumber.

2.2 LUMBER

2.2.1 Structural Lumber

Except where a specific grade is indicated or specified, Any of the species and grades listed in AWC NDS that have allowable unit stresses in pounds per square inch (psi) not less than allowable unit stresses indicated. Use

for joists, rafters, headers, trusses, beams (except collar beams), columns, posts, stair stringers, girders, and all other members indicated to be stress rated. Structural lumber exposed to view in must be appearance grade of SYP#2 species meeting the allowable unit stresses specified. Design of members and fastenings must conform to AITC TCM. Other stress graded or dimensioned items such as blocking, carriages, and studs must be standard or No. 2 grade except that studs may be Stud grade.

2.2.2 Framing Lumber

Framing lumber such as studs, plates, caps, collar beams, cant strips, bucks, sleepers, nailing strips, and nailers and board lumber such as subflooring and wall and roof sheathing must be one of the species listed in the table below. Minimum grade of species must be as listed. Provide certified sustainably harvested framing lumber.

Table of Grades for Framing and Board Lumber					
Grading Rules	Species	Framing	Board Lumber		
WWPA G-5 standard grading rules	Aspen, Douglas Fir-Larch, Douglas Fir South, Engelmann Spruce-Lodgepole Pine, Engelmann Spruce, Hem-Fir, Idaho White Pine, Lodgepole Pine, Mountain Hemlock, Mountain Hemlock, Mountain Hemlock-Hem-Fir, Ponderosa Pine-Sugar Pine, Ponderosa Pine-Lodgepole Pine, Subalpine Fir, White Woods, Western Woods, Western Hemlock	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	All Species: No. 3 Common		

Table of Grades for Framing and Board Lumber						
Grading Rules	Species	Framing	Board Lumber			
WCLIB 17 standard grading rules	Douglas Fir-Larch, Hem-Fir, Mountain Hemlock, Sitka Spruce, Western Cedars, Western Hemlock	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	All Species: Standard			
SPIB 1003 standard grading rules	Southern Pine	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	No. 2 Boards			
SCMA Spec standard specifications	Cypress	No. 2 Common	No. 2 Common			
NELMA Grading Rules standard grading rules	Balsam Fir, Eastern Hemlock-Tamarack, Eastern Spruce, Eastern White Pine, Northern Pine, Northern Pine-Cedar	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	All Species: No. 3 Common except Standard for Eastern White and Northern Pine			

Table of Grades for Framing and Board Lumber			
Grading Rules	Species	Framing	Board Lumber
RIS Grade Use standard specifications	Redwood	All Species: Standard Light Framing or No. 3 Structural Light Framing (Stud Grade for 2x4 nominal size, 10 feet and shorter)	Construction Heart
NHLA Rules rules for the measurement and inspection of hardwood and cypress lumber	Cypress	No. 2 Dimension	No. 2 Common

2.3 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware must be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials must be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be hot-dip zinc-coated in accordance with ASTM A153/A153M. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather must be copper alloy or hot-dipped galvanized fasteners as recommended by the treated wood manufacturer.

2.3.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.3.2 Lag Screws and Lag Bolts

ASME B18.2.1.

2.3.3 Wood Screws

ASME B18.6.1.

2.3.4 Nails

ASTM F547, size and type best suited for purpose; staples must be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails must be sufficient to extend 1

inch into supports. In general, 8-penny or larger nails must be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails must be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing must be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing must be in accordance with the recommended nailing schedule contained in AWC WFCM. Where detailed nailing requirements are not specified, nail size and spacing must be sufficient to develop an adequate strength for the connection. The connection's strength must be verified against the nail capacity tables in AWC NDS. Reasonable judgment backed by experience must ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector must be used.

2.3.5 Timber Connectors

Unless otherwise specified, timber connectors must be in accordance with TPI 1, APA EWS T300 or AITC TCM.

2.3.6 Clip Angles

Steel, 3/16 inch thick, size as indicated; or zinc-coated steel or iron commercial clips designed for connecting wood members.

2.3.7 Joist Hangers

Steel or iron, zinc coated, sized to fit the supported member, of sufficient strength to develop the full strength of the supported member in accordance with ICC IBC, and furnished complete with any special nails required.

2.3.8 Tie Straps

For joists supported by the lower flange of steel beams, provide 1/8 by 1-1/2 inch steel strap, 2 feet long .

2.3.9 Metal Framing Anchors

Construct anchors to the configuration shown using hot dip zinc-coated steel conforming to ASTM A653/A653M, G90. Except where otherwise shown, Steel must be not lighter than 18 gage. Special nails supplied by the manufacturer must be used for all nailing.

2.4 AIR INFILTRATION BARRIER

Air infiltration barrier must be building paper meeting the requirements of ASTM C1136, Type IV, style optional or a tear and puncture resistant olefin building wrap (polyethylene or polypropylene) with a moisture vapor transmission rate of 125 g per square meter per 24 hours in accordance with ASTM E96/E96M, Desiccant Method at 23degrees C or with a moisture vapor transmission rate of 670 g per square meter per 24 hours in accordance with ASTM E96/E96M, Water Method at 23 degrees C.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Conform to AWC WFCM unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame members for the passage of pipes, conduits, and ducts. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise must be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts must be drawn up tight. Timber connections and fastenings must conform to AWC NDS. Use slate or steel shims when leveling joists, beams, and girders on masonry or concrete. Do not use shimming on wood or metal bearings. When joists, beams, and girders are placed on masonry or concrete, a wood base plate must be positioned and leveled with grout. The joist, beam, or girder must then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket must be formed into the wall. The joist, beam, or girder must then be placed into the pocket and leveled with a steel shim.

3.1.1 Beams and Girders

Set beams and girders level and in alignment and anchor to bearing walls, piers, or supports with U-shaped steel strap anchors. Embed anchors in concrete or masonry at each bearing and through-bolt to the beams or girders with not less than two bolts. Provide bolts not less than 1/2 inch in diameter and with plate washers under heads and nuts. Install beams and girders not indicated otherwise with 8 inch minimum end bearing on walls or supports. Install beams and girders into walls with 1/2 inch clearance at the top, end, and sides. Provide joints and splices over bearings only and bolt or spike together.

3.1.2 Joists

Provide joists of the sizes and spacing indicated, accurately and in alignment, and of uniform width. Joists must have full bearing on sills, plates, beams,; provide laps over bearing only and spike. Where joists are of insufficient length to produce a 12 inch lap, butt joists over bearing and provide wood scabs 2 nominal inches thick by depth of joists by 24 inches long or metal straps 1/4 by $1 \ 1/2$ inch by not less than 18 inches long nailed to each joist with not less than four 10-penny nails, or approved sheet metal connectors installed in accordance with the manufacturer's recommendations. Provide joists built into masonry with a beveled fire cut so that the top of the joist does not enter the wall more than one inch. Provide metal hangers for joists framing into the side of headers, beams, or girders. When a portion of the joist extends above the top flange of a steel beam or girder, provide a 3/8 inch space between the top flange and the extended portion of the joists to allow for shrinkage of joists. The minimum joist end bearing must be 4 inches, and joists built into concrete or masonry must have a 1/2 inch minimum clearance at the top, end, and sides. For joists approved to be bored for the passage of pipes or conduits, bore through the neutral axis of the joist. Provide steel joist hangers of proper size and type to receive the ends of all framed joists.
3.1.2.1 Doubled Joists

Provide under bearing walls and partitions running parallel with the floor joists, around chimneys, and at other openings where joists are cut and framed. Double, space for clearance, block apart 4 feet on center, rigidly frame, and spike together joists under partitions that are to receive ducts, pipes, and conduits.

3.1.2.2 Tie Straps

For joists supported by the lower flange of steel beams, provide straps at every fourth joist and the corresponding fourth joist on the opposite side. Tie joists across the top of the steel beam with a steel strap. Form straps to lie flat across the top of the beam and twist at the ends to provide flat contact with the side of each joist. Nail each strap at each end with three 10-penny nails spaced 2 inches o.c.

3.1.2.3 Joist Anchors

Provide anchors for each fourth joist supported by a masonry wall. Build wall end of anchors into the wall. Nail anchor to the joist with three 10-penny nails spaced 2 inches o.c. Anchor the first three joists parallel to concrete or masonry walls at bridging points, but not less than 8 feet o.c. from end walls. Let anchors into the tops of each joist and spike to the top of joist with one 10-penny nail. Extend anchors at least 4 inches into the wall.

3.1.3 Ceiling Joists

Size as indicated and set accurately and in alignment. Toe-nail joists to all plates with not less than three 10-penny nails. Frame openings in ceilings with headers and trimmers.

3.1.4 Metal Framing Anchors

Provide framing anchors at every rafter to fasten rafter to plates and studs against uplift movement and forces as indicated. Anchors must be punched and formed for nailing so that nails will be stressed in shear only. Nails must be zinc-coated; drive a nail in each nail hole provided in the anchor.

3.2 MISCELLANEOUS

3.2.1 Wood Blocking

Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.2 Wood Furring

Provide where shown and as necessary for facing materials specified. Except as shown otherwise, furring strips must be nominal one by 3, continuous, and spaced 16 inches o.c. Erect furring vertically or horizontally as necessary. Nail furring strips to masonry. Do not use wood plugs. Provide furring strips around openings, behind bases, and at angles and corners. Furring must be plumb, rigid, and level and must be shimmed as necessary to provide a true, even plane with surfaces suitable to receive the finish required. Form furring for cornices, offsets and breaks in

walls or ceilings on 1 by 4 wood strips spaced 16 inches o.c.

3.2.3 Wood Bumpers

Dress to the sizes indicated, and bevel edges. Bore, countersink, and bolt bumpers in place.

3.3 INSTALLATION OF TIMBER CONNECTORS

Install timber connectors in conformance with requirements of AWC NDS.

- 3.4 ERECTION TOLERANCES
 - a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, must be within the following limits:
 - (1) Layout of walls and partitions: 1/4 inch from intended position;
 - (2) Plates and runners: 1/4 inch in 8 feet from a straight line;
 - (3) Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
 - (4) Face of framing members: 1/4 inch in 8 feet from a true plane.
 - b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive must be within the following limits:
 - (1) Layout of walls and partitions: 1/4 inch from intended position;
 - (2) Plates and runners: 1/8 inch in 8 feet from a straight line;
 - (3) Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and
 - (4) Face of framing members: 1/8 in 8 feet from a true plane.
- 3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components must be done in accordance with Section 01 45 35 SPECIAL INSPECTIONS.

3.6 WASTE MANAGEMENT OF WOOD PRODUCTS

In accordance with the Waste Management Plan and as specified. Separate and reuse scrap sheet materials larger than 2 square feet, framing members larger than 16 inches, and multiple offcuts of any size larger than 12 inches. Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

Separate composite wood from other wood types and recycle or reuse.

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Do not leave any wood, shavings, sawdust, or other wood waste buried in fill or on the ground, unless for planned future use. Do not burn

scrap lumber that has been pressure treated, or lumber that is less than one year old.

-- End of Section --

SECTION 06 20 00

FINISH CARPENTRY 08/16, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

	SC PS 20 (2015) American Softwood Lumber	Standard
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AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME B18.2.1 (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
- ASME B18.2.2 (2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASME B18.6.1 (2016) Wood Screws (Inch Series)

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M4 (2023) Standard for the Care of Preservative-Treated Wood Products

AWPA U1(2023) Use Category System: UserSpecification for Treated Wood

ASTM INTERNATIONAL (ASTM)

- ASTM D2898 (2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
- ASTM F547 (202) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA Rules (2015) Rules for the Measurement & Inspection of Hardwood & Cypress

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION (NELMA)

NELMA Grading Rules (2013) Standard Grading Rules for Northeastern Lumber

REDWOOD INSPECTION SERVICE (RIS) OF THE CALIFORNIA REDWOOD ASSOCIATION (CRA)

RIS Grade Use (1998) Redwood Lumber Grades and Uses

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2017) Adhesive and Sealant Applications

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1003(2014) Standard Grading Rules for SouthernPine Lumber

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB 17 (2015) Standard Grading Rules

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA G-5 (2017) Western Lumber Grading Rules

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S.4 (2015A) Preservative Treatment for Millwork

WOOD MOULDING AND MILLWORK PRODUCERS ASSOCIATION (WMMPA)

WMMPA WM 6 (2007) Quality Industry Standards Booklet

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings Indicating All Wood Assemblies; G[, []]

SD-03 Product Data

Wood Products; G[, []]

REPAIR AND RENOVATION MATTHEW JONES HOUSE 100% DESIGN SUBMISSION Engineered Wood Products; G[, [___]] Treated Wood Products; G[, [__]] Soffits; G[, [__]] Fascias and Trim; G[, [__]] Hardware and Accessories; G[, [__]] [VOC Content for Siding; S [] SD-04 Samples Samples; G[, [__]] SD-07 Certificates Certificates of Grade; G[, [__]]

]1.3 DETAIL DRAWINGS

Submit detail drawings indicating all wood assemblies proposed for use in the project. Indicate materials, species, grade, density, grain, finish details of construction, location of use in the project, finishes, types, method and arrangement of fasteners, and installation details. This includes all fabricated assemblies.

1.4 PRODUCT DATA

Submit Manufacturers printed data including proposed species, grade, density grain, and finish as applicable; sufficient to demonstrate compliance with this specification for each type of wood product specified. For treated wood products also provide documentation of environmentally safe preservatives for each type of wood product specified.

Provide Manufacturers printed data for hardware and all wood accessories including but not limited to edge banding, adhesives, and sealers.

1.5 SAMPLES

Samples indicating proposed species, grade, density grain, and finish for each type of wood product specified. Provide samples of sufficient size to show pattern and color ranges of proposed products.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver wood products to the jobsite in an undamaged condition. Stack materials to ensure ventilation and drainage. Protect against dampness before and after delivery. Store materials under cover in a well ventilated enclosure and protect against extreme changes in temperature and humidity. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Do not store products in building until wet trade materials are dry and humidity of the space is within wood manufacturer's tolerance limits for storage.

1.7 QUALITY ASSURANCE

1.7.1 Certifications

1.7.1.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

- 1.7.1.2 1.7.1.2.1 1.7.1.2.2
-]1.7.2 Lumber

Identify each piece or each bundle of lumber, millwork, and trim by the grade mark of a recognized association or independent inspection agency certified by the Board of Review of the ALSC to grade the species.

1.7.3 Pressure Treated Lumber and Plywood

Inspect each treated piece in accordance with AWPA U1.

1.7.4 Non-Pressure Treated Woodwork and Millwork

Mark, stamp, or label to indicate compliance with WDMA I.S.4.

1.7.5 Fire-Retardant Treated Lumber

Each piece must bear an Underwriters Laboratories fire resistance label or comparable label of another nationally recognized independent fire retardant materials testing laboratory.

PART 2 PRODUCTS

- 2.1 WOOD PRODUCTS
- 2.1.1 Sizes and Patterns of Wood Products

Provide yard and board lumber sizes in accordance with ALSC PS 20. Provide shaped lumber and millwork in the patterns indicated and in standard patterns of the association covering the species. Size references, unless otherwise specified, are nominal sizes. Provide actual sizes within manufacturing tolerances allowed by the applicable standard.

2.1.2 Species and Grades

Provide in accordance with AWPA U1 Use Category System Tables unless otherwise specified herein.

2.1.3 Trim, Finish, and Frames

Provide species and grades listed in the table below for wood materials that must be painted. For materials that must be stained, have a natural, or a transparent finish, provide materials one grade higher than those listed in the table below. Provide trim, except window stools and aprons with hollow backs.

TABLE OF GRADES FOR WOOD TO RECEIVE PAINT FINISH				
Grading Rules	Species	Exterior and Interior Trim, Finish, and Frames		
WWPA G-5 standard grading rules	Aspen, Douglas Fir-Larch, Douglas Fir South, Engelmann Spruce-Lodgepole Pine, Engelmann Spruce, Hem-Fir, Idaho White Pine, Lodgepole Pine, Mountain Hemlock, Mountain Hemlock-Hem-Fir, Ponderosa Pine-Sugar Pine, (Ponderosa Pine-Lodgepole Pine,) White Woods, (Western Woods,) Western Cedars, Western Hemlock	All Species: C & BTR. Select (Choice & BTR Idaho White Pine) or Superior Finish. Western Red Cedar may be graded C & BTR. Select or A & BTR in accordance with Special Western Red Cedar Rules.		
WCLIB 17 standard grading rules	Douglas Fir-Larch, Hem-Fir, Mountain Hemlock, Sitka Spruce, Western Cedars, Western Hemlock	All Species: C & BTR VG, except A for Western Red Cedar		
SPIB 1003 standard grading rules	Southern Pine	C & BTR		
NHLA Rules	Cypress	C-Select		
NELMA Grading Rules standard grading rules **	Balsam Fir, Eastern Hemlock-Tamarack, Eastern Spruce, Eastern White Pine, Northern Pine, Northern Pine, Northern White Cedar	All Species: C-Select except C & BTR for Eastern White Pine and Norway Pine		
RIS Grade Use standard specifications	Redwood	Clear, Clear All Heart		
NHLA Rules	Cypress	B Finish		
	Red Gum, Soft Elm, Birch	Select or BTR (for interior use only)		

Note: **

http://www.nelma.org/library/2013-standard-grading-rules-for-northeastern-lumber/

[]2.1.4 Stairs

Treads 1-1/4 inches thickness, clear red or white oak. Risers 1 inch nominal finish lumber.

2.1.5 Shoe Mould

Clear red or white oak, 1/2 by 5/8 inch unless otherwise indicated.

- 2.2 SOFFITS
- 2.3 FASCIAS AND TRIM
- 2.3.1 Wood

Provide species and grades for all fascia and trim, including exterior door and window casings, in accordance with AWPA U1 Use Category System Tables. Provide sizes indicated. Metal corners may be provided in lieu of wood corner boards for horizontal siding. If metal corners are used, provide galvanized steel or aluminum, completely coated with primer compatible for the specific metal substrate.

2.4 MOISTURE CONTENT OF WOOD PRODUCTS

Kiln dry lumber. Kiln dry treated lumber after treatment. Maximum moisture content of wood products at time of delivery to the jobsite, and when installed, must be as follows:

- a. Interior Paneling: 6 percent.
- b. Interior Finish Lumber, Trim, and Millwork: 1-1/4 Inches Nominal or Less in Thickness: 6percent on 85 percent of the pieces and 8percent on remainder.
- c. Exterior Treated and Untreated Finish Lumber and Trim: 4 inches Nominal or Less in Thickness: 19 percent.
- d. Exterior Wood Siding: 15 percent.
- e. Provide moisture content of other materials in accordance with the applicable standards.
- 2.5 PRESERVATIVE TREATMENT OF WOOD PRODUCTS
- 2.5.1 Non-Pressure Treatment

Treat woodwork and millwork, such as exterior trim, door trim, and window trim, in accordance with WDMA I.S.4, with either 2 percent copper napthenate, 3 percent zinc napthenate, or 1.8 percent copper-8-quinolinolate. Provide a liberal brush coat of preservative treatment to field cuts and holes.

2.5.2 Pressure Treatment

Treat lumber and plywood used on the exterior of buildings or in contact with masonry or concrete with a waterborne preservative listed in AWPA U1 (P series is included therein by reference) as applicable, and inspected in accordance with AWPA U1. Identify treatment on each piece of material by the quality mark of an agency accredited by the Board of Review of the

American Lumber Standards Committee. Provide treated plywood to a reflection level as follows:

Preservative treat exterior wood moulding and millwork that will be within 18 inches of soil or in contact with water or concrete in accordance with WMMPA WM 6. Provide a field treatment in accordance with AWPA M4 of exposed areas of treated wood that have been cut or drilled. Items of all-heart material of cedar, cypress, or redwood do not require preservative treatment except when in direct contact with soil.

2.6 FIRE-RETARDANT TREATMENT

2.6.1 Wood Products

Pressure treat fire-retardant treated lumber and plywood in accordance with AWPA U1. Comply with material use as defined in AWPA U1 for Interior Type [A] [and] [B] and Exterior Type. Treatment and performance inspection must be conducted by a qualified independent testing agency that establishes performance ratings. Each piece or bundle of treated material must bear identification of the testing agency to indicate performance with such rating. Subject treated materials that will be exposed to rain wetting to an accelerated weathering technique in accordance with ASTM D2898, Method A, prior to being tested for compliance with AWPA U1.

Treat the following items:

[____].

2.7 HARDWARE AND ACCESSORIES

Provide sizes, types, and spacings of hardware and accessories as recommended in writing by the wood product manufacturer, except as otherwise specified.

2.7.1 Wood Screws

ASME B18.6.1.

2.7.2 Bolts, Nuts, Lag Screws, and Studs

ASME B18.2.1 and ASME B18.2.2.

2.7.3 Nails

Use nails of a size and type best suited for each application and in accordance with ASTM F547. Use hot-dipped galvanized or aluminum nails for exterior applications. For siding, provide nails of sufficient length to extend 1-1/2 inches into supports, including wood sheathing over framing. Where nailing is impractical, provide screws of a size and type best suited for each application.

- 2.8 FABRICATION
- 2.8.1 Quality Standards (QS)
- 2.8.1.1 Grades

The terms "Premium," "Custom," and "Economy" refer to the quality grades defined in NAAWS 3.1. Provide items not otherwise specified in a specific

grade as "Custom" grade.

2.8.1.2 Adhesives

Select adhesives for durability and permanent bonding. Address factors such as materials that must be bonded, expansion and contraction, bond strength, fire rating, moisture resistance, and manufacturer's recommendations.

[Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building.

]PART 3 EXECUTION

Do not install building construction materials that show visual evidence of biological growth.

3.1 FINISH WORK

Apply primer to finish work before installing. Where practicable, shop assemble and finish millwork items. Construct joints tight and in a manner to conceal shrinkage but to avoid cupping, twisting and warping after installation. Miter trim and mouldings at exterior angles; cope at interior angles and at returns. Provide millwork and trim in maximum practical lengths. Fasten finish work with finish nails. Provide blind nailing where practicable. Set face nails for putty stopping.

3.1.1 Exterior Finish Work

Machine sand exposed flat members and square edges. Machine finish semi-exposed surfaces. Construct joints to exclude water. In addition to nailing, glue joints with waterproof glue as necessary for weather resistant construction. Evenly distribute end joints in built-up members. Provide shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and waterproof glue. Unless otherwise indicated, provide fascia and other flat members 3/4 inch thick minimum. Provide door and window trim in single lengths. Provide braced, blocked, and rigidly anchored cornices for support and protection of vertical joints. Provide soffits in largest practical size. Align joints of plywood over centerlines of supports. Fasten soffits with aluminum or stainless steel nails. Back prime all concealed surfaces of exterior trim.

3.1.2 Interior Finish Work

After installation, sand exposed surfaces smooth. Provide window and door trim in single lengths.

3.1.3 Door Frames

Set plumb and square. Provide solid blocking at not more than 16 inches on center for each jamb. Position blocking to occur behind hinges and lock strikes. Double wedge frames and fasten with finish nails. Set nails for putty stopping.

3.1.4 Thresholds

Unless otherwise indicated, provide thresholds and cut to fit at jambs. Fasten thresholds with casing nails. Set nails for putty stopping.

3.1.5 Window Stools and Aprons

Provide stools with rabbets over window sills. Provide aprons with returns cut accurately to profile of member.

3.1.6 Bases

Provide flat member with a moulded top . Fasten base to framing or to grounds. Set one-piece wood base after finish flooring is in place.

3.1.7 Finish Stair Work

Fit, nail, screw, bolt, and glue stair work together to form a strong, rigid structure without squeaks or vibrations. Anchor newels and posts securely to stair framing. Cut newels, posts, and drops accurately around floor construction to make a tight fit. Embed balusters into treads and landings and secure with glue. Provide railings with straight runs that follow the slope of the stairs and have smooth curved turns. Return railing profile at ends and secure joints with bolts and nuts in accordance with structural load requirements for railings. Secure railing to posts and newels with concealed anchors. Support wall rails on metal brackets spaced near ends and at not more than 5 feet on center.

3.2 SOFFITS

3.2.1 Wood

Provide panels with edges at joints spaced in accordance with manufacturer's written instructions and with all edges backed by framing members. Nail panels 3/8 inch from edges at 6 inches on center and at intermediate supports at 12 inches on center. Provide panels in maximum practicable lengths.

3.3 FASCIA AND EXTERIOR TRIM

Construct, caulk, and machine sand exposed surfaces and edges to exclude water. In addition to nailing, glue joints as necessary for weather resistance. Evenly distribute end joints in built-up members. Shoulder joints in flat work. Reinforce backs of wide-faced miters with metal rings and glue. Provide fascia and other flat members in maximum practicable lengths. Braced, block, and rigidly anchor cornices for support and protection of vertical joints.

3.4 MOULDING AND INTERIOR TRIM

Install mouldings and interior trim straight, plumb, level and with closely fitted joints. Provide exposed surfaces machine sanded at the shop. Cope

returns and interior angles at moulded items and miter external corners. Shoulder intersections of flatwork to ease any inherent changes in plane. Provide window and door trim in single lengths. Blind nail to the extent practicable. Set and stop face nailing with a nonstaining putty to match the applied finish. Use screws for attachment to metal; set and stop screws in accordance with the same quality requirements for nails.

-- End of Section --

SECTION 07 22 00

ROOF AND DECK INSULATION 08/23

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017)	Minimum	Design	Loads	for	Buildings
	and Ot	her Struc	ctures			

ASTM INTERNATIONAL (ASTM)

ASTM C1289 (2023a) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board ASTM D4601/D4601M (2004; R 2020) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing (2023) Standard Test Method for Surface ASTM E84 Burning Characteristics of Building Materials FM GLOBAL (FM) FM 4450 (1989) Approval Standard for Class 1 Insulated Steel Deck Roofs FM 4470 (2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction FM APP GUIDE (updated on-line) Approval Guide http://www.approvalguide.com/ INTERNATIONAL CODE COUNCIL (ICC) ICC IBC (2021) International Building Code SCIENTIFIC CERTIFICATION SYSTEMS (SCS) SCS SCS Global Services (SCS) Indoor Advantage UNDERWRITERS LABORATORIES (UL) UL 1256 (2023) Fire Test of Roof Deck Constructions

UL 2818

(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Insulation Board Layout and Attachment; G[, []]

Verification of Existing Conditions; G[, []]

SD-03 Product Data

Insulation; G[, [____]]

Fasteners; G[, [____]]

Moisture Control; G[, []]

SD-05 Design Data

Wind Resistance; G[, [____]]

SD-06 Test Reports

Flame Spread Rating; G[, []]

SD-07 Certificates

Installer Qualifications; G[, []]

Certificates Of Compliance For Felt Materials; G[, []]

Indoor Air Quality For Insulation; S

SD-08 Manufacturer's Instructions

Nails and Fasteners; G[, [___]]

Roof Insulation; G[, []]

1.3 SHOP DRAWINGS

Submit insulation board layout and attachment indicating methods of attachment and spacing of fasteners on each board, transitions, tapered components, thicknesses of materials, and closure and termination

conditions. Show locations of ridges, valleys, crickets, interface with, and slope to, roof drains. Base shop drawings on verified field measurements and include verification of existing conditions. Show location and spacing of wood nailers required for securing of insulation [and backnailing of roofing felts.

1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for cover board or coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

1.5 MANUFACTURER'S INSTRUCTIONS

Include field of roof, perimeter, and corner attachment requirements.

Provide a complete description of installation sequencing for each phase of the roofing system. Include weatherproofing procedures.

1.6 QUALITY CONTROL

Provide certification of installer qualifications from the insulation manufacturer confirming the specific installer has the required qualifications for installing the specific roof insulation system(s) indicated.

Provide certificates of compliance for felt materials.

[1.7 WIND RESISTANCE REQUIREMENTS

The complete roof system assembly must be rated and installed to resist wind loads calculated in accordance with ASCE 7 and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Coordinate with roof covering attachment requirements and submit wind resistance test certification, attachment patterns for field, perimeter, and corner roof areas along with perimeter and corner boundary dimensions.

]1.8 FIRE PERFORMANCE REQUIREMENTS

1.8.1 Insulation in Roof Systems

Comply with the requirements of ICC IBC [or UL 1256] [or FM 4450][or FM 4470]. Roof insulation must have a flame spread rating of 75 or less when tested in accordance with ASTM E84. Additional documentation of compliance with flame spread rating is not required when insulation of the type used for this project as part of the specific roof assembly is listed and labeled as FM Class 1 approved.[Only roof assemblies that pass FM 4450 are permitted.]

1.8.2 Thermal Barrier Requirements

Separate polyurethane insulation from a combustible deck with a thermal barrier of glass mat gypsum roof board or other approved barrier material in accordance with the requirements of the ICC IBC[or FM 4450][or FM 4470][or UL 1256].

1.8.3 Fire Resistance Ratings for Roofs

Provide in accordance with ICC IBC Chapter 7 and Table 721.1(3) Min Fire

and Smoke Protection For Floor and Roof Systems.

1.9 CERTIFICATIONS

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification by other third-party programs. Provide current product certification documentation from certification body.

1.10 DELIVERY, STORAGE, AND HANDLING

1.10.1 Delivery

Deliver materials to the project site in manufacturer's unopened and undamaged standard commercial containers bearing the following legible information:

- a. Name of manufacturer
- b. Brand designation
- c. Specification number, type, and class, as applicable, where materials are covered by a referenced specification
- [d. Asphalt flashpoint (FP), equiviscous temperature (EVT), and finished blowing temperature (FBT).
-] Deliver materials in sufficient quantity to allow continuity of the work.
- 1.10.2 Storage and Handling

Store and handle materials in accordance with manufacturer's printed instructions. Protect from damage, exposure to open flame or other ignition sources, wetting, condensation, and moisture absorption. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or biological growth. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment.

1.11 ENVIRONMENTAL CONDITIONS

As per manufacturer's recommendations or Government's instructions, do not install roof insulation during inclement weather or when air temperature is below 40 degrees F and interior humidity is 45 percent or greater, or when there is visible ice, frost, or moisture on the roof deck.

- 1.12 PROTECTION
- [][1.12.1 Special Protection

Provide special protection as approved by the insulation manufacturer.

][]1.12.2 Completed Work

Cover completed work with cover board for the duration of construction. Avoid traffic on completed work particularly when ambient temperature is above 80 degrees F. Replace crushed or damaged insulation prior to roof surface installation.

PART 2 PRODUCTS

2.1 INSULATION

2.1.1 Insulation Types

Provide one, or an assembly of a maximum of three, of the following roof insulation materials. Provide roof insulation that is compatible with attachment methods for the specified insulation and roof membrane.

a. Polyisocyanurate Board: Provide in accordance with ASTM C1289 REV A [Type I, foil faced both sides] [or] [Type II, fibrous felt or glass mat membrane both sides], except minimum compressive strength of [25] [20] pounds per square inch (psi).

b.

2.1.2 Indoor Air Quality

Provide certification of indoor air quality for insulation.

2.1.3 Prohibited Materials

Products that contain high ozone depleting or high Global Warming Potential (GWP) blowing agents are prohibited. For a list of acceptable substitute foam blowing agents for the type of insulation used see https://www.epa.gov/snap/foam-blowing-agents. Provide validation of acceptable foam blowing agents that no prohibited materials are used.

2.1.4 Insulation Thickness

As necessary to provide the thermal resistance (R-value) indicated. Base calculation on the R-value for aged insulation.

][][2.2 SHEATHING PAPER FOR WOOD DECKS

Rosin-sized building paper or unsaturated felt weighing not less than 5 pounds per 100 square feet.

-]2.3 MOISTURE CONTROL
- [2.3.1 Vapor Retarder
- [2.3.1.1 Asphalt Saturated Felt Base Sheet for Single Layer Application

Provide in accordance with ASTM D4601/D4601M, weighing not less than 35 pounds per 100 square feet.

][]][]2.4 FASTENERS

Provide flush-driven fasteners through flat round or hexagonal steel or plastic plates. Provide zinc-coated steel plates, flat round not less than 1 3/8 inch diameter, hexagonal not less than 28 gage. Provide high-density plastic plates, molded thermoplastic with smooth top surface, reinforcing ribs and not less than 3 inches in diameter. Fully recess fastener head into plastic plate after it is driven. Form plates to prevent dishing. Do not use bell or cup shaped plates. Provide fasteners in accordance with insulation manufacturer's recommendations for holding power when driven, or a minimum of [40] [120] pounds each in steel deck, whichever is the higher

minimum. Provide fasteners for steel or concrete decks in accordance with
FM APP GUIDE (<u>https://www.approvalguide.com/</u>) for Class I roof deck
construction, and spaced to withstand uplift pressure of [60] [90] [___]
pounds per square foot.

2.4.1 Roofing Nails for Wood Decks

Barbed 11 gage, zinc-coated nails with 7/16 to 5/8 inch diameter heads or annular ring shank, square head, one piece composite nails. Provide nails long enough to penetrate wood deck at least 5/8 inch without protruding through underside of decking.

]2.5 [WOOD] [ENGINEERED METAL FRAMING] NAILERS

[Pressure-preservative treated wood as specified in Section 06 10 00 ROUGH CARPENTRY.] [Provide galvanized steel or aluminum engineered metal framing for use as nailers and attached to substrate with self-tapping screws.]

- PART 3 EXECUTION
- 3.1 EXAMINATION AND PREPARATION
- 3.1.1 Surface Inspection

Ensure surfaces are clean, smooth, and dry prior to application. Ensure surfaces receiving vapor retarder are free of projections that might puncture the vapor retarder. Check roof deck surfaces, including surfaces sloped to roof drains and outlets, for defects before starting work.

The Contractor must inspect and approve the surfaces immediately before starting installation. Prior to installing vapor retarder, perform the following:

a. Examine wood decks to ascertain that deck boards have been properly nailed in accordance with IBC and wind uplift requirements and that exposed nail heads have been set.

]3.1.2 Surface Preparation

To correct defects and inaccuracies in roof deck surface to eliminate poor drainage from hollow or low spots, perform the following:

a. Fill or cover cracks or knot holes larger than 1/2 inch in diameter in wood decks as necessary to form an unyielding surface.

3.2 INSTALLATION OF VAPOR RETARDER

Install vapor retarder in direct contact with roof deck surface . Lay vapor retarder at right angles to direction of slope. Install first ply of base sheet as specified herein for the specific deck.

[][3.2.1 Vapor Retarder on Wood Decks

Lay first ply of two-ply system dry with each sheet lapping 2 inches over

the preceding sheet. Lap ends not less than 4 inches. Stagger laps a minimum of 12 inches. Nail felt at 6 inch intervals alongside laps and install two rows of nails approximately 11 inches apart down longitudinal center of each sheet, with nails staggered at 18 inches on center. For vapor retarder consisting of one layer of asphalt base sheet, lap each sheet 4 inches over the preceding sheet. Provide end laps not less than 4 inches and stagger laps a minimum of 12 inches. Cement side and end laps together with solid mopping of asphalt or heavy coat of asphalt roof cement. Nail side laps at 6 inch intervals. Apply asphalt mopping at a rate of 20 to 35 lbs per 100 square feet. Install two rows of nails approximately 11 inches apart down longitudinal center of each sheet, with nails staggered at 18 inches on center.

][][]3.3 INSULATION INSTALLATION

Apply insulation in two layers with staggered joints when total required thickness of insulation exceeds 1/2 inch. Lay insulation so that continuous longitudinal joints are perpendicular to direction of [felts for the built-up] roofing, as specified in Section [____], and end joints of each course are staggered with those of adjoining courses. When using multiple layers of insulation, provide joints of each succeeding layer that are parallel and offset in both directions with respect to the layer below. Keep insulation 1/2 inch clear of vertical surfaces penetrating and projecting from roof surface. Verify required slopes to each roof drain.

[][][3.3.1 Installation Using Only Mechanical Fasteners

Secure total thickness of insulation with penetrating type fasteners.

][3.3.2 Installation Using Mechanical Fasteners and Foam Adhesive

Secure first layer of insulation [and thermal barrier] to deck with piercing or self-drilling, self-tapping fasteners. Engage fasteners by driving them through insulation into top flange of steel deck. Use driving method prescribed by fastener manufacturer. Locate insulation joints parallel to ribs of deck on solid bearing surfaces only, not over open ribs. Secure succeeding layers with foam adhesive using installation procedures as recommended by the insulation manufacturer for adhering the insulation and resisting the required wind uplift pressure. Installation must bond insulation securely to substrates without damaging insulation and substrates.

][]3.4 PROTECTION

3.4.1 Protection of Applied Insulation

Completely cover each day's installation of insulation with finished roofing specified in [____] on same day. Phased construction is not permitted. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, until permanent roofing and flashing are applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces is not permitted. Provide smooth, clean board or plank walkways, runways, and platforms near supports, as necessary, to distribute weight in accordance with [indicated live load limits of roof construction] [a [____] psf live load limit]. Protect exposed edges of insulation with cutoffs at the end of each workday or whenever precipitation is imminent. Cutoffs must be two layers of bituminous-saturated felt set in plastic bituminous cement [or single ply] [or EPDM membrane] set in roof cement. Fill all profile voids in cutoffs

to prevent trapping moisture below the membrane. Remove cutoffs when work resumes.

3.4.2 Damaged Work and Materials

Restore work and materials that become damaged during construction to original condition or replace with new materials.

3.5 INSPECTION

Establish and maintain inspection procedures to assure compliance of the installed roof insulation with Contract requirements. Remove, replace, correct in an approved manner, any work found not in compliance. Quality control must include, but is not limited to, the following:

- a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.
- b. Verification of certification, listing or label compliance with FM Data Sheets.
- c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.
- d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.
- e. Inspection of mechanical fasteners; type, number, length, and spacing.
- f. Coordination with other materials, cants, sleepers, and nailing strips.
- g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.
- h. Installation of cutoffs and proper joining of work on subsequent days.
- i. Continuation of complete roofing system installation to cover insulation installed same day.
- j. Verification of required slope to each roof drain.

-- End of Section --

SECTION 07 60 00

FLASHING AND SHEET METAL 08/23

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM E2112	(2023) Standard Practice for Installation of Exterior Windows, Doors and Skylights

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0429 (2022) The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control and Reroofing

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793 (2012) Architectural Sheet Metal Manual, 7th Edition

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI/FM 4435/ES-1 (2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems

1.2 GENERAL REQUIREMENTS

Finished sheet metal assemblies must form a weathertight enclosure without waves, warps, buckles, fastening stresses or distortion, while allowing for expansion and contraction without damage to the system. The sheet metal installer is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal modifications required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit

continuous, uninterrupted roofing operations.

1.2.1 General Material Requirements

All materials specified in this Section installed in conjunction with the roofing system must be provided by the roofing system manufacturer, or by a manufacturer approved by the roofing system manufacturer for use in the roofing system, and must form a part of the Warranty as required by the applicable roofing system Section.

[1.2.2 Additional Wind Uplift Requirements

All flashing and edge materials specified in this Section must be installed in conjunction with the requirements of the roofing system to meet the requirements of ES-1 wind uplift. Details must include but not limited to ANSI/SPRI/FM 4435/ES-1 (ES-1), "Wind Test Design Standard for Edge Systems" used with Low Slope Roofing Systems, Test Methods: RE-1, RE-2 and RE-3 using uplift roofing details of the NRCA 0429.

]1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Gutters; G[, [____]]
Downspouts; G[, []]

Splash Pans; G[, []]

Drip Edges; G[, [____]]

SD-04 Samples

Finish Samples; G[, []]

SD-07 Certificates

Warranty on Finishes; G[, []]

SD-08 Manufacturer's Instructions

Instructions for Installation; G[, []]

Quality Control Plan; G[, []]

] SD-10 Operation and Maintenance Data

Cleaning and Maintenance; G[, []]

1.4 MISCELLANEOUS REQUIREMENTS

1.4.1 Product Data

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Indicate thicknesses, dimensions, fastenings, anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

1.4.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

1.4.3 Operation and Maintenance Data

Submit detailed instructions for installation and quality control during installation, cleaning and maintenance, for each type of assembly indicated.

1.5 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until installation.

PART 2 PRODUCTS

2.1 MATERIALS

Use any metal listed by NRCA 0429 or SMACNA 1793 for a particular item, unless otherwise indicated. Provide materials and configurations in accordance with NRCA 0429 or SMACNA 1793 for each material, while also meeting the minimum thickness requirements specified in this Section. Different items need not be of the same metal, except that[if copper is selected for any exposed item, all exposed items must be copper, and that] contact between dissimilar metals must be avoided.

Provide sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate

sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used, except as follows:

2.1.1 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.1.2 Copper, Sheet and Strip

Provide in accordance with ASTM B370, cold-rolled temper, H 00 (standard).

2.1.3 Lead Sheet

Provide in a minimum weight of 4 pounds per square foot.

2.1.4 Solder

Provide in accordance with ASTM B32, 95-5 tin-antimony.

- 2.1.5 Reglets
- 2.1.5.1 Metal Reglets

Provide factory fabricated caulked type or friction type reglets with a minimum opening of 1/4 inch and a depth of 1-1/4 inch, as approved.

2.1.5.1.1 Caulked Reglets

Provide with rounded edges, temporary reinforcing cores, and accessories as required for securing to adjacent construction. Provide built-up mitered corner pieces for inside and outside corners.

2.1.5.1.2 Friction Reglets

Provide with flashing receiving slots not less than 5/8 inch deep, one inch jointing tongues, and upper and lower anchoring flanges installed at 24 inch maximum snap-lock type receiver.

2.1.6 Splash Pans

Provide splash pans where downspouts discharge onto roof surfaces and at locations indicated. Unless otherwise indicated, provide pans not less than 24 inches long by 18 inches wide with metal ribs across bottoms of pans. Provide sides of pans with vertical baffles not less than one inch high in the front, and 4 inches high in the back.

2.1.7 Roofing Felt

Provide in accordance with ASTM D226/D226M [Type I][Type II].

2.1.8 Asphalt Primer

Provide in accordance with ASTM D41/D41M.

2.1.9 Fasteners

Use the same metal as, or a metal compatible with the item fastened. Confirm compatibility of fasteners and items to be fastened to avoid galvanic corrosion due to dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing is not permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.[Secure flashing at one-half the normal interval to ensure a wind-resistant installation.]

3.1.3 Cleats

Provide cleats for sheet metal 18 inches and over in width. Space cleats evenly not over 12 inches on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inches wide by 3 inches long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. [Where the fastening is to be made to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry.]Pre-tin cleats for soldered seams.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inches or less in thickness.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inches.

3.1.6 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pre-tin edges of sheet metal before soldering is begun. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.6.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pre-tinned. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

- 3.1.7 Protection from Contact with Dissimilar Materials
- 3.1.7.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.7.2 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.7.3 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.8 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and at not more than 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum gravel stops and fascia by expansion and contraction joints spaced not more than 12 feet apart.

3.1.9 Base Flashing

Lay the base flashings with each course of the roof covering, shingle fashion, where practicable, where sloped roofs abut chimneys, curbs, walls, or other vertical surfaces. Extend up vertical surfaces of the flashing not less than 8 inches and not less than 4 inches under the roof covering. Where finish wall coverings form a counterflashing, extend the vertical leg of the flashing up behind the applied wall covering not less than 6 inches. Overlap the flashing strips[or shingles] with the previously laid flashing

not less than 3 inches. Fasten the strips[or shingles] at their upper edge to the deck. Horizontal flashing at vertical surfaces must extend vertically above the roof surface and fastened at their upper edge to the deck a minimum of 6 inches on center with hex headed, galvanized shielded screws a minimum of 2 inch lap of any surface. Solder end laps and provide for expansion and contraction. Install and fit the flashings so as to be completely weathertight. Provide factory-fabricated base flashing for interior and exterior corners. Do not use metal base flashing on built-up roofing.

3.1.10 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inches above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inches. Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inches by 8 inches or may be of the preformed single piece type. Provide end laps in counterflashings not less than 3 inches and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form flashings to the required shapes before installation. Factory form corners not less than 12 inches from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inches apart; on chimneys place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4 inch and extend not less than 2 inches into the walls. Install counterflashing to provide a spring action against base flashing.[Utilize two piece counterflashing components to minimize damage of counterflashing and reglets during future reroofing activities.]

3.1.11 Metal Reglets

Keep temporary cores in place during installation. Ensure factory fabricated caulked type or friction type, reglets have a minimum opening of 1/4 inch and a minimum depth of 1-1/4 inch, when installed.

3.1.11.1 Caulked Reglets

Wedge flashing in reglets with lead wedges every 18 inches, caulked full and solid with an approved compound.

3.1.11.2 Friction Reglets

Install flashing snap lock receivers at 24 inches on center maximum. When flashing has been inserted the full depth of the slot, caulk the slot, lock[with wedges], and fill with sealant.

3.1.12 Metal Drip Edges

Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction, at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 3 inches and secure with compatible nails spaced not more than 10 inches on center along upper edge.

3.1.13 Gutters

The hung type of shape indicated and supported on underside by brackets that permit free thermal movement of the gutter. Provide gutters in sizes indicated complete with mitered corners, end caps, outlets, brackets, and other accessories necessary for installation. Bead with hemmed edge or reinforce the outer edge of gutter with a stiffening bar not less than 3/4by 3/16 inch of material compatible with gutter. Fabricate gutters in sections not less than 8 feet. Lap the sections a minimum of one inch in the direction of flow or provide with concealed splice plate 6 inches minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Provide expansion-type slip joints midway between outlets. Install gutters below slope line of the roof so that snow and ice can slide clear. Support gutters onadjustable hangers spaced not more than 30 inches on center. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from compatible metals.

3.1.14 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the wood substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths. Provide end joints to telescope not less than 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than one inch away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.14.1 Terminations

Neatly fit into the drainage connection the downspouts terminating in drainage lines and fill the joints with a portland cement mortar cap sloped away from the downspout. Provide downspouts terminating in splash blocks with elbow-type fittings. Provide splash pans as specified.

3.1.15 Splash Pans

Install splash pans lapped with horizontal roof flanges not less than 4 inches wide to form a continuous surface. Bend the rear flange of the pan to contour of can't strip and extend up 6 inches under the side wall covering or to height of base flashing under counterflashing. Bed the pans and roof flanges in plastic bituminous cement and strip-flash as specified.

3.1.16 Eave Flashing

One piece in width, applied in 8 to 10 foot lengths with expansion joints spaced as specified in paragraph EXPANSION AND CONTRACTION. Provide a 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 10 inches on center. Locate the upper edge of flashing not less than 18 inches from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave flashing intersects metal valley flashing, secure with one inch flat locked joints with cleats that are 10 inches on center.

3.1.17 Flashing at Wall Openings

Install pan flashing in the rough opening sill at all penetrations in the exterior wall assemblies, such as windows, louvers, storefronts and curtain walls. Pan sill flashing must have end dams at both jambs a minimum of 2 in high and a rear dam of 2 in high. Flashing must comply with ASTM E2112 and SMACNA 1793.

3.1.18 Stepped Flashing

Provide stepped flashing where sloping roofs surfaced with shingles abut vertical surfaces. Place separate pieces of base flashing in alternate shingle courses.

3.1.19 Copings

Provide coping with locked and soldered seam. Terminate outer edges in edge strips. Install with sealed [lap joints][cover plate joints][standing seam joints] as indicated.

3.1.20 Through Wall Flashing

Provide through wall flashing as required in the applicable wall system Sections.

3.2 PAINTING

Touch ups in the field may be applied only after metal substrates have been cleaned and pretreated in accordance with manufacturer's written instructions and products.

Field-paint dissimilar sheet metals in contact to separate and deter galvanic interactions.

[]3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

[3.5 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the Contract requirements. Remove work that is not in compliance with the Contract and replace or correct. Include quality control, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

- b. Verification that specified material is provided and installed.
- c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.5.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Provide a copy of the documentation to the Contracting Officer at the end of each day.

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES					
Sheet Metal Items	[Copper kilograms per square foot]	[Aluminum, inch]	[Stainless Steel, inch]	[Terne-Coated Stainless Steel, inch]	[Zinc-Coated Steel, U.S. Std. Gage]
[Building Expans:	ion Joints	5]	L	I	
[Cover]	16	.032	.015	.015	24
[Waterstop-bellow or flanged, U-type.]	16	-	.015	.015	-
[Covering on minor flat, pitched or curved surfaces]	20	.040	.018	.018	-
[Downspouts and leaders]	16	.032	.015	.015	24
[Downspout clips and anchors]	-	.040 clip .125 anchor	-	-	-
[Downspout straps, 2-inch]	48 (a)	.060	.050	-	-
[Conductor heads]	16	.032	.015	.015	-
[Scupper lining]	20	.032	.015	.015	-
[Strainers, wire diameter or gage]	No. 9 gage	.144 diameter	.109 diameter	-	
[Flashings:]					
[Base]	20	.040	.018	.018	24

TABLE	I. SHEET	METAL WEI	GHTS, THICK	NESSES, AND GAG	GES
Sheet Metal Items	[Copper kilograms per square foot]	[Aluminum, inch]	[Stainless Steel, inch]	[Terne-Coated Stainless Steel, inch]	[Zinc-Coated Steel, U.S. Std. Gage]
[Cap (Counter-flashing	16	.032	.015	.015	26
[Eave]	16	-	.015	.015	24
[Spandrel beam]	10	-	.010	.010	-
[Bond barrier]	16	-	.015	.015	-
[Stepped]	16	.032	.015	.015	-
[Valley]	16	.032	.015	.015	-
[Roof drain]	16 (b)				
[Pipe vent sleave	e (d)]				
[Coping]	16	-	-	-	-
[Gravel stops and	d fascia:]				
[Extrusions]	_	.075	-	-	-
[Sheets, corrugated]	16	.032	.015	.015	-
[Sheets, smooth]	20	.050	.018	.018	24
[Edge strip]	24	.050	.025	-	-
[Gutters:]					
[Gutter section]	16	.032	.015	.015	24
[Continuous cleat]	16	.032	.015	.015	24
[Hangers, dimensions]	1 inch by 1/8 inch (a)	1 inch by .080 inch (c)	1 inch by . inch	-	-
[Joint Cover plates (See Table II)]	16	.032	.015	.015	24
[Reglets (c)]	10	-	.010	.010	-
[Splash pans]	16	.040	.018	.018	-
(a) Brass.	(a) Brass.				

					1
TABLE	I. SHEET	METAL WEI	GHTS, THICK	NESSES, AND GA	GES
	1		1	1	
Sheet Metal Items	[Copper kilograms per square foot]	[Aluminum, inch]	[Stainless Steel, inch]	[Terne-Coated Stainless Steel, inch]	[Zinc-Coated Steel, U.S. Std. Gage]
(b) May be lead weighing 4 pounds per square foot.					
(c) May be polyvinyl chloride.					
(d) 2.5 pound m is impractical, material.	inimum lea refer to p	ad sleeve w Daragraph S	with 4 inch SINGLE PIPE	flange. Where VENTS for opti	e lead sleeve onal

TABLE II. SHEET METAL JOINTS					
TYPE OF JOINT					
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks		
Joint cap for building expansion seam, cleated joint at roof	1.25 inch single lock, standing seam, cleated	1.25 inch single lock, standing			
Flashings					
Base	One inch 3 inch lap for expansion joint	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum manufacturer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound.		
Cap-in reglet	3 inch lap	3 inch lap	Seal groove with joint sealing compound.		

	TABLE II. SHE	ET METAL JOINTS		
TYPE OF JOINT				
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks	
Reglets	Butt joint		Seal reglet groove with joint sealing compound.	
Eave	One inch flat locked, cleated. One inch loose locked, sealed expansion joint, cleated.	One inch flat locked, locked, cleated one inch loose locked, sealed expansion joints, cleated	Same as base flashing.	
Stepped	3 inch lap	3 inch lap		
Valley	6 inch lap cleated	6 inch lap		
Edge strip	Butt	Butt		
Gravel stops:			1	
Extrusions		Butt with 1/2 inch space	Use sheet flashing beneath and a cover plate	
Sheet, smooth	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing backup plate.	
Sheet, corrugated	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing beneath and a cover plate or a combination unit	
Gutters	1.5 inch lap, riveted and soldered	One inch flat locked riveted and sealed	Aluminum producers recommended hard setting sealant for locked aluminum joints.	
(a) Provide a 3 recommended seala	inch lap elastomeric ant.	flashing with man	ufacturer's	
(b) Seal Polyvir sealant.	nyl chloride reglet w	with manufacturer's	recommended	

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] -- End of Section --

SECTION 07 62 13

COPPER SHEET METAL FLASHING AND TRIM 08/09

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM F547	(202) Standard Terminology of Nails for Use with Wood and Wood-Base Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793 (2012) Architectural Sheet Metal Manual, 7th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-51145 (Rev D; Notice 1; Notice 2; Notice 3; Notice 4) Flux, Soldering, Non-Electronic, Paste and Liquid

1.2 SYSTEM DESCRIPTION

a. Perform sheet metalwork to accomplish weathertight construction. Install the work without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction. Perform cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades by sheet metal mechanics. Hem exposed edges. Angle bottom edges of exposed vertical surfaces to form drips. Form flashing into a 3-dimensional configuration, at the end of a run. to direct water to the outside of the system. Weights and thicknesses of copper flashing are as specified in TABLE 1. Install joints as specified in TABLE 2. Provide accessories and other items, essential to complete the sheet metal installation, though not specifically indicated or specified.

- b. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations. Pack factory-fabricated components in cartons marked with the manufacturer's name or trademark printed or embossed at frequent intervals to permit easy identification. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in other sections.
- c. Use proper insulation to avoid galvanic action between copper and iron or steel. Insulate the copper covering the steel member with insulation; placing strips of sheet lead between the two metals; or by heavily tinning the iron.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Sheet Metal

SD-03 Product Data

Contractor Quality Control

SD-04 Samples

Materials

1.4 DELIVERY, STORAGE, AND HANDLING

Adequately package and protect materials during shipment and inspect for damage, dampness, and wet-storage stains upon delivery to the jobsite. Clearly label materialsas to type and manufacturer. Handle sheet metal items carefully to avoid damage. Store materials in dry, weathertight, ventilated areas until installation.

PART 2 PRODUCTS

2.1 MATERIALS

Provide materials conforming to the requirements specified below, and those given in TABLE 1. Materials exposed to weather must be copper. Recyclable materials (building paper, etc.) must conform to EPA requirements in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Submit samples of materials proposed for use, upon request.
2.1.1 Asphalt Roof Cement

ASTM D4586/D4586M, Type I.

2.1.2 Fasteners

Provide fasteners conforming to TABLE 1. Provide nails conforming to ASTM F547 or as approved. Provide copper nails and rivets. Provide bronze screws and bolts. Fasteners must be the best type for the application.

2.1.3 Felt

ASTM D226/D226M, Type II.

2.1.4 Flux

CID A-A-51145, Type I.

2.1.5 Slip Sheet

Building paper meeting the requirements of ASTM C1136, Type IV, style optional.

2.1.6 Sheet Metal

Furnish sheet metal conforming to ASTM B152/B152M, ASTM B370, Light cold-rolled temper (H00) copper. Submit drawings showing weights, gauges, or thickness of sheet metal; type of material; joining, expansion-joint spacing, and fabrication details; and installation procedures. Do not deliver materials to the site until after the approved detail drawings have been returned to the Contractor.

2.1.7 Solder

ASTM B32 Sn50.

2.2 SEALANTS AND SEALING COMPOUNDS

Sealants and sealing compounds are specified in Section 07 92 00 JOINT SEALANTS.

PART 3 EXECUTION

3.1 EXISTING COPPER SHEET METAL

Salvage existing, original, historic copper sheet metal elements that are intact and serviceable and reuse whenever possible. This may include, but is not limited to, gutters, hangers, downspouts, connectors, leader heads, leader straps, basket strainers, splash pans, and other architectural sheet metal elements such as finials, and decorative panels. When work involves repair and replacement of copper sheet metal elements, match new elements to existing original elements as closely as possible.

- 3.2 SOLDERING AND SEAMING
- 3.2.1 Soldering

Pretin edges of sheet metals, except lead coated materialbefore soldering is begun. Solder slowly with well heated soldering irons to thoroughly

heat the seams and completely sweat the solder through the full width of the seam. Scrape or wire-brush edges of lead coated material to be soldered to produce a bright surface, and brush a liberal amount of flux in seams before soldering is begun. Solder immediately after applying flux. Upon completion of soldering, thoroghly clean the acid flux residue from the sheet metal with a solution of washing soda in water and rinse with clean water.

3.2.2 Seams

Finish flat-lock and soldered-lap seams no less than 1 inch wide. Do not lap unsoldered plain-lap seams less than 3 inches unless otherwise specified. Make flat seams in the direction of the flow.

3.3 CLEATS

Provide a continuous cleat where indicated or specified to secure loose edges of the sheet metalwork. Space butt joints approximately 1/8 inch apart. Fasten the cleat to the supporting construction with nails evenly spaced not over 12 inches on centers. Where the fastening is to be made to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Install the cleat for fascia anchorage to extend below the supporting construction to form a drip and to allow the flashing to be hooked over the lower edge at least 3/4 inch. The cleat must be wide enough to provide adequate bearing area to ensure a rigid installation. Where horizontal nailer is vented for insulation and the cleat is placed over masonry or concrete, install the cleat over 1/16 inch thick metal washers placed at screws. Use metal washers that are electrolytically compatible with the continuous cleat.

3.4 EXPANSION JOINTS

Provide expansion joints at 40 foot intervals, except that where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing, provide an additional joint. Space joints evenly.

3.5 FLASHINGS

3.5.1 General

Install flashings at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls is covered in appropriate sections for such work. Turn cap flashings around exterior corners of masonry or concrete walls at least 2 inches, secure into masonry joints and into concrete with expansion anchors and seal with No. 2 or 4 sealing compound. Use corner units that have mitered joints, install with 3 inch lap joint over flashings on each side. Unless otherwise indicated, terminate through-wall flashing 1/2 inch inside each exposed face of the wall. Provide cap flashings over base flashings. Cover up perforations in flashings made by masonry anchors by applying bituminous plastic cement at the perforation. For exposed and unfastened flashings, turn the edge of the strip under 1/2 inch. Install flashing on top of joint reinforcement.

3.5.2 Base Flashings

a. Extend base flashings under the uppermost row of tile the full depth of

the tile or at least 4 inches over the tile immediately below the metal.

- b. Turn up the vertical leg of the metal not less than 4 inches and preferably 8 inches on the abutting surface. Where a vertical surface butts against the roof slope, build the base flashing into each course of tile as it is laid, turning the metal out 4 inches on the tile and at least 8 inches above the roof.
- c. Where the roof stops against a stuccoed wall, secure a wood 2 x 4 with a beveled top edge to the wall. Then turn out base flashing over the tile at least 4 inches and bend up vertically at least 3 inches on the board.
- d. Turn out the base flashing 4 inches on the roof surface and from 6 to 8 inches on the vertical surface for either sloping or flat slate roofs.
- e. Use base flashings where posts, flagpoles, or scuttles project through the roof. Vent pipes must have base flashings in the form of special sleeves and/or EPDM boots.

3.5.3 Cap Flashings (Counterflashings)

Where the base flashing is not covered by vertical tile or siding, build a cap flashing into the masonry joints lapping not less than 2 inches vertically, extending down over the base flashing 4 inches, and the edge bent back and up 1/2 inch.

3.5.4 Stepped Flashing

Install stepped flashing where sloping roofs surfaced with tiles abut vertical surfaces. Place separate pieces of base flashing in alternate tile courses. Extend each piece of base flashing out onto the roof at least 4 inches and nail to the deck. Extend the stepped base flashing up along the wall not less than 4 inches and stop beneath the cap flashing or anchor beneath wood siding in frame construction. Set cap flashings in a reglet into masonry and concrete construction, and lap cap flashing over the flashing below not less than 3 inches. Lap the stepped base flashing at vertical joints between the sections not less than 3 inches.

3.5.5 Eave and Rake Flashings

Place eave and rake flashings in accordance with SMACNA 1793.

3.6 REGLETS

Reglets must be a factory fabricated product, complete with fittings and special shapes as may be required. Provide open-type reglets filled with fiberboard or other suitable separator to prevent crushing of the slot during installation. Locate reglets no less than 8 inches nor more than 16 inches above roofing not having cant strips or locate no less than 5 inches nor more than 13 inches above cant strip. Do not space reglet plugs over 12 inches on centers and fill reglet grooves with sealant. Friction or slot-type reglets must have metal flashings inserted the full depth of slot and must be lightly punched every 12 inches to crimp the reglet and cap flashing together.

3.7 DOWNSPOUTS

Set downspouts plumb and no less than 1 inch from the wall. Provide

leaders to connect gutters on overhanging eaves to downspouts. Set leaders with a slope no less than 0.3 degrees, 1/16 inch per foot or more than 30 degrees below a horizontal line. Fit leaders over the outlet tube in gutter bottom. Fit into and rivet to the downspout. Rivet spacing more than 2 inches is not permitted. Loosely set strainers in the eave tube opening in gutter. Make joints between lengths of downspouts by telescoping the end of the upper lengths at least 3/4 inch into the lower length. Neatly fit downspouts terminating in drainage lines into downspout boots and fill the joint with a portland cement mortar cap sloped away from downspout. Provide downspouts terminating at splash blocks or splash pans with stock elbow-type fittings. Provide downspout hangers adjacent to the joint at the top of each section of downspout, except that the bottom section must have an additional strap adjacent to the bottom joint when splash blocks or splash pans are required. Hangers must be 1/16 x 1 inch flat stock of the same material as the downspout.

3.8 GUTTERS

Terminate gutters at least 1/2 inch away from vertical surfaces. [Anchor supporting cleats to the structure at spacings not exceeding 16 inches.] Fasten gutter brackets and spacersto roof nailer by screws or deformed shank-type nails and interlock with or fasten to the leading edge of gutter. Gutter spacers must be $1/16 \times 1$ inch flat-stock of the same material as the gutter. Alternate brackets and spacers at not more than 36 inches on centers. hang gutters with high points at ends or equidistant from downspouts and level

3.9 SPLASH PANS

Install splash pans where downspouts discharge on roof surfaces and at other locations as indicated. Pans must be of size indicated. Bed pans and roof flanges in plastic bituminous cement and strip flashed.

3.10 CONTRACTOR QUALITY CONTROL

Establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Promptly remove and replace or correct any work found not to be in compliance with the contract in an approved manner. Submit a Quality Assurance Plan, including a checklist of points to be observed, prior to start of roofing work. Quality control includes, but is not limited to, the following:

- a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.
- b. Verification of compliance of materials before, during, and after installation.
- c. Inspection of sheet metalwork, for proper size and thickness, fastening and joining, and proper installation.

Document the actual quality control observations and inspections and furnish a copy of the documentation to the Contracting Officer at the end of each day.

TABLE 1 - COPPER SHEET MET	AL WEIGHTS AND THICKNESSES
Item Description	Copper (oz/square foot)
Building expansion joints: Cap	16
Building expansion joints:	16
Waterstop - bellows or	
flanged-U-type	
Cleats (Continuous)	24
Covering on minor flat, pitched or curved surfaces	20
Downspouts, heads and leaders	16
Flashings: Base	20
Flashings: Cap, stepped or valley	16
Gravel stops and fasciae: Sheets,	16
Gutters (girth): Up to15 inches	16
Gutters (girth): 15 to 20 inches	16
Gutters (girth): 20 to 25 inches	20
Gutters (girth): 25 to 30 inches	24
Gutter brackets (girth): Up to15 inches	1/8 x 1 inch
Gutter bracket s (girth): 15 to 20 inches	1/4 x 1 inch
Gutter brackets (girth): 20 to 24 inches	1/4 x 1 1/2 inch
Gutter cleats and cover plates	16
Scupper lining	20
Strainers (wire gauge)	No. 9
Reglets (1)	10
Splash pans	16
Copings	16
Pitch pockets	16
Through-wall, flashings above roof line	16
Through-wall, below roof line, except as otherwise specified in paragraph MATERIALS	10

TABLE 2 - COPPER	R SHEET METAL JOINTS
Item Designation	Type of Joint
Building expansion joint at roof	1-1/4 inch single lock standing seam, cleated
Cleats (Continuous)	Butt
Flashings: Base	1 inch flat locked, soldered 3 inch lap for expansion joint
Cap - in reglet	3 inch lap
Cap - two - piece	Receiver 3 inch lap Cap piece 3 inch lap
Stepped	3 inch lap
Through-wall spandrel flashing (metal	1-1/2 inch mechanical interlock
Valley	6 inch lap, cleated
Sheet, corrugated	Butt with 1/4 inch
Sheet, smooth	Butt with 1/4 inch space
Gutters	1-1/2 inch lap, riveted and soldered
Pitch pockets	1 inch soldered lap
Reglets	Butt joint

-- End of Section --

SECTION 08 14 00

WOOD DOORS 08/16, CHG 1: 08/18

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.

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

ANSI/WDMA I.S.1A	(2013) Doors	Interior	Architectural	Wood	Flush
ANSI/WDMA I.S.6A	(2013) Rail Do	Interior pors	Architectural	Stile	and

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

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Doors; G[, [____]]
```

Submit drawings or catalog data showing each type of door unit [; include descriptive data of head and jamb weatherstripping with installation instructions]. Indicate within drawings and data the door types and construction, sizes, thickness, [methods of assembly,] [door louvers,] and [glazing,].

SD-03 Product Data

```
Doors; G[, [ ]]
```

```
[
    Accessories
    Water-resistant Sealer
    Sample Warranty
[ Sound Transmission Class Rating; G[, [___]]
][ Fire Resistance Rating; G[, [___]]
] SD-04 Samples
```

Doors

Prior to the delivery of wood doors, submit a sample section of each type of door which shows the stile, rail, veneer, finish, and core construction.

Door Finish Colors; G[, []]

Submit a minimum of three color selection samples [, minimum 3 by 5 inches in size representing wood stain] [for selection by the Contracting Officer].

SD-06 Test Reports

Cycle-Slam

Hinge Loading Resistance

Submit cycle-slam test report for doors tested in accordance with ANSI/WDMA I.S.1A, and hinge loading resistance test report for doors tested in accordance with ANSI/WDMA I.S.6A.

SD-07 Certificates

Certificates of Grade

- [Certified Sustainably Harvested Stile and Rail Wood Doors; S
-][Certified Sustainably Harvested Flush Wood Doors; S
-][Indoor Air Quality for Particleboard and Agrifiber Door Cores: S
-] SD-11 Closeout Submittals

Warranty

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inch 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

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 [specified] free of urea-formaldehyde resins.

2.1.1 Stile and Rail Doors

[Premium][Standard] grade Ponderosa Pine doors or [premium or select][standard] stile and rail doors conforming to ANSI/WDMA I.S.6A. Furnish laminate panels in not less than three ply thickness. Provide flat panels with a minimum finished panel thickness of 1/2 inch and 3/4 inch thickness for raised panels.[Provide certified sustainably harvested stile and rail wood doors.]

2.2 FABRICATION

2.2.1 Marking

Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

2.2.2 Quality and Construction

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

2.2.3 Preservative Treatment

Treat doors scheduled for restrooms, janitor closets and other possible wet locations including exterior doors with a water-repellent preservative treatment and so marketed at the manufacturer's plant.

2.2.4 Adhesives and Bonds

ANSI/WDMA I.S.1A. Use Type I bond for exterior doors and Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

2.2.5 Prefitting

Provide factory prefinished factory prefitted doors for the specified hardware, door frame and door-swing indicated. Machine and size doors at the factory by the door manufacturer in accordance with the standards under which the doors are produced and manufactured. The work includes sizing, beveling 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 to coordinate the work.

2.2.6 Finishes

2.2.6.1 Field Painting

Factory prime or seal doors, and field paint.

2.2.6.2 Color

Provide door finish colors in accordance with Section 09 06 00 SCHEDULES FOR FINISHES.

2.2.7 Water-Resistant Sealer

Provide manufacturer's standard water-resistant sealer compatible with the

specified finish[es].

2.3 SOURCE QUALITY CONTROL

Meet or exceed the following minimum performance criteria of stiles of "B" and "C" label fire doors utilizing standard mortise leaf hinges:

- a. Cycle-slam: Heavy Duty Doors: 500,000 cycles with no loose hinge screws or other visible signs of failure when tested in accordance with the requirements of ANSI/WDMA I.S.1A
- b. Hinge loading resistance: Heavy Duty doors: 475 pounds force when tested for direct screw withdrawal in accordance with ANSI/WDMA I.S.6A using a No. 12, 1-1/4 inch long, steel, fully threaded wood screw. Drill 5/32 inch pilot hole, use 1-1/2 inch opening around screw for bearing surface, and engage screw full, except for last 1/8 inch. Do not use a steel plate to reinforce screw area.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

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 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inch. Door warp must not exceed 1/4 inch when measured in accordance with ANSI/WDMA I.S.1A.

[3.1.1 Weatherstripping

Install doors in strict accordance with the door manufacturer's printed installation instructions and details. Weatherstrip exterior swing-type doors at sills, heads and jambs to provide weathertight installation. Apply weatherstripping at sills to bottom rails of doors and hold in place with a brass or bronze plate. Apply weatherstripping to door frames at jambs and head. Shape weatherstripping at sills to suit the threshold. -- End of Section --

SECTION 09 01 90.50

PREPARATION OF HISTORIC WOOD AND METAL SURFACES FOR PAINTING 05/09, CHG 1: 08/17

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100	(2017;	Sup	pl 20	20)	Docu	ument	ation	of	the
	Thresh	old 1	Limit	Val	ues	and	Biolog	gica	ıl
	Exposu	re I	ndice	S					

ASTM INTERNATIONAL (ASTM)

ASTM D3274	(2009; R 2017) Standard Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of

Exterior Paint Films

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC PA Guide 5	(2023) Guide to Maintenance Coating of Steel Structures in Atmospheric Service
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2018) Hand Tool Cleaning
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

1.2 SUMMARY

The procedures proposed for the accomplishment of the work must provide for safe conduct of the work, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, and coordination with other work in progress. Submit the

names, quantity represented, and intended use for proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular batch is 50 gallons or less. Submit manufacturer's current printed product description, safety data sheets (SDS) and technical data sheets for each product. Provide detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times for each product submitted. Include in the work plan a Safety and Health plan describing procedures for handling monitoring, and disposition of VOCs and other hazardous and toxic materials. Submit one copy of the Work Plan and a certificate stating that products proposed for use meet the VOC regulations of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations. Test the materials designated by the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Work Plan; G[, [___]]

Materials

Qualifications

SD-07 Certificates

Work Plan

1.4 QUALITY ASSURANCE

Perform work in compliance with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. Include analyses of the potential impact of surface preparation operations on personnel and on others involved in and adjacent to the work zone in the Activity Hazard Analysis.

1.4.1 Worker Exposures

Do not expose workers to chemical substances exceeding limits as established by ACGIH 0100.

1.4.2 Training

Inform workers, having access to an affected work area, of the contents of the applicable SDS and of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive dust, mists, and odors from the surface preparation operations. Workers involved in surface preparation and clean-up must be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the

project. Instruct personnel having a need to use respirators and masks in the use and maintenance of such equipment.

1.4.3 Coordination

Coordinate work to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from surface preparation and cleaning operations.

1.4.4 Qualifications

Provide qualified workers trained and experienced in the preparation for painting of wood and metal surfaces in historic structures, submit documentation of 5 consecutive years of work of this type and a statement certified by the Contractor attesting that the experience and qualifications of the workers (journeymen) comply with the specifications.. Provide a list of similar jobs identifying when, where, and for whom the work was done and a current point-of-contact for identified references.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver paint removers, solvents, and other chemicals, used for surface preparation, in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Furnish such materials in containers not larger than 5 gallons; store them in accordance with the manufacturer's written directions; and, as a minimum, store them off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F.

1.6 ENVIRONMENTAL REQUIREMENTS

Unless otherwise recommended by the product manufacturer, provide an ambient temperature between 45 and 95 degrees F when applying paint removers, solvents, or other preparation materials.

PART 2 PRODUCTS

2.1 PAINT REMOVERS

Provide chemical paint removers that are a commercial item specifically manufactured for the type of paint to be removed.

2.2 EPOXY CONSOLIDANTS

2.2.1 Liquid Consolidant

Provide liquid wood consolidant consisting of a 2-part, low-viscosity liquid epoxy that meets the criteria of Table 1.

2.2.2 Epoxy Paste

Provide epoxy paste consisting of a 2-part, thixotropic paste that meets the criteria of Table 1.

TABLE 1				
	LIQUID CONSOLIDANT	EPOXY PASTE		
Properties	Low-Viscosity Liquid	No-Slump, Thixotropic Paste		
Toxicity	Low	Very Low		
Toxicity Cured	Non-Toxic	Non-Toxic		
Ratios	1:1 by Volume	1:1 by Volume		
Pot Life @ Room Temp.	30 minutes min.	50 minutes min		
Hardening @ Room Temp.	1 hr. or longer	1 hr. or longer		
Hardening @ 140 deg. F	16 min. or less	18 min. or less		
Viscosity Poises @ 72 deg. F	4.7 max.	Thixotropic paste		
Solids	95 percent min.	98 percent min.		
Tensile Strength	4000 psi	2500 psi		
Elongation	50 percent	4 percent		
Compressive Strength				
Failure	19,000 psi			
Yield	3500 psi	5500 psi		

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Use methods for preparation of historic wood and metal surfaces for painting which are the gentlest possible to achieve the desired results. Do not damage or marr substrate materials in the process of surface preparations. Collect and analyze samples of the existing paint finishes for the purpose of documentation or matching, if required by the contract documents. Material and application requirements for paints are covered in Section 09 90 00 PAINTS AND COATINGS.

3.2 VENTILATION

Ventilate interior work zones, having a volume of 10,000 cubic feet or less, at a minimum of 2 air exchanges per hour. Maintain ventilation in larger work zones by means of mechanical exhaust. Exhaust solvent vapors outdoors, away from air intakes and workers. Temporarily seal return air inlets in the work zone before start of work until the prepared surfaces have dried. Operators and personnel in the vicinity of paint removal processes involving chemicals or mechanical action (sanding or blasting) must wear respirators.

3.3 PROTECTION OF AREAS NOT TO BE PAINTED

Remove or protect items not to be painted, which are in contact with or adjacent to painted surfaces, prior to surface preparation and painting operations. Replace items removed prior to painting when painting is completed. Following completion of painting, reinstall removed items. Restore surfaces contaminated by preparation materials to original condition.

3.4 CLEANING OF SURFACES

Provide surfaces that are clean and free of grease, dirt, dust and other foreign matter before application of paint or surface treatments. After cleaning, exhibit a surface disfigurement rating of 7 or greater when evaluated in accordance with ASTM D3274. Clean dirt and surface contaminants by brush with solutions of water and detergent or trisodium phosphate, then rinsed clean with water and let dry. Clean surfaces on which mildew or other microbiological growth is present with a detergent solution containing household bleach. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Provide low toxicity cleaning solvents with a flashpoint in excess of 100 degrees F. Program cleaning so that dust and other contaminants will not fall on newly prepared or newly painted surfaces.

3.5 EXISTING PAINT

Test existing paint for adhesion to substrate in accordance with ASTM D3359, Test Method A and obtain a rating of 4 or better in order to be considered sound. Existing paint meeting this requirement may be considered a satisfactory base for repainting.

3.6 PAINT REMOVAL

Remove flaking, cracking, blistering, peeling or otherwise deteriorated paint by scraping with hand scrapers. After scraping, remove large areas of paint or paint on architectural details using sanders, heat guns or heat plates, or chemical paint removers. Remove paint to bare substrate or first sound paint layer. Do not use open flame heat devices. Mechanical paint removal must not damage or mar the substrate material.

3.6.1 Chemical Paint Removers

Use chemical paint removers in accordance with manufacturer's recommendations. If chemical strippers are used, neutralizesubstrate to a pH of 5 to 8.5 after stripping.

3.6.2 Lead Paint

In preparation of lead-based painted surfaces for repainting, follow the procedures described in Section 02 83 00 LEAD REMEDIATION.

3.7 SURFACE PREPARATION

After cleaning and removal of deteriorated paint, feather and sand edges of remaining chipped paint. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas. Roughen slick surfaces. Clean rusty metal surfaces in accordance with [SSPC SP 1] [SSPC SP 2] [SSPC SP 3] [SSPC SP 5/NACE No. 1] [SSPC SP 6/NACE No.3] [SSPC 7/NACE No.4] [

SSPC SP 10/NACE No. 2]. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8. Provide new, proposed coatings that are compatible with existing coatings. If existing surfaces are glossy, reduce the gloss.

3.8 WOOD SURFACES

Clean wood surfaces of foreign matter. Prime or touch up surfaces adjacent to surfaces to receive water-thinned paints before applying water-thinned paints. Scrape and clean small, dry seasoned knots, and give a thin coat of commercial knot sealer before application of the priming coat. Scrape off pitch on large, open, unseasoned knots and all other beads or streaks of pitch, or, if it is still soft, remove with mineral spirits or turpentine, and thinly coat the resinous area with knot sealer.

3.8.1 Interior Wood Surfaces

Sand interior wood surfaces to receive stain. Give oak and other open-grain wood to receive stain a coat of wood filler recommended by the finish manufacturer not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth. Sanding of wood floors is specified in Section 09 64 29 WOOD STRIP AND PLANK FLOORING. Moisture content of the wood must not exceed 12 percent as measured by a moisture meter, unless otherwise authorized.

3.8.2 Wood Repair

Remove and repair badly decayed areas. Replace areas and pieces decayed beyond repair with new pieces that match originals in all respects. Patch moderately decayed areas, weathered, or gouged wood with approved patching compounds, and sand smooth. Identify and correct the source or cause of wood decay prior to application of patching materials. Completely dry wet wood to a moisture content not exceeding 12 percent, as measured by a moisture meter, to its full depth before patching, unless otherwise authorized. Wood that is to be patched must be clean of dust, grease, and loose paint.

3.8.2.1 Epoxy Wood Repair

Apply epoxy wood repair materials in accordance with manufacturer's written instructions. Follow health and safety instructions in accordance with the manufacturer's instructions. Use clean mixing equipment to avoid contamination. Provide mix and proportions as directed by the manufacturer. Provide batches large enough to complete the specific job intended. Completely cure batching materials before painting or reinstallation of patched pieces.

3.8.2.2 Epoxy Consolidant and Epoxy Paste

Use epoxy liquid wood consolidant: 1) to penetrate and impregnate deteriorated wood sections in order to reinforce wood fibers that have become softened or absorbent. 2) as a primer for areas that are to receive epoxy paste filler. Use epoxy paste to fill areas where portions of wood are missing such as holes, cracks, gaps, gouges, and other voids.

3.8.3 Exposed Ferrous Metals

Spot-prime exposed ferrous metals such as nail heads on or in contact with wood surfaces to be painted with water-thinned paints, with a suitable

corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.8.4 Finishing Nails

Set finishing nails, and prime all holes and surface imperfections. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler must be compatible with subsequent coatings.

3.8.5 Wood Preservative

Treat areas of bare wood in exterior locations prone to excessive moisture or standing water with a commercial, fungicide, paintable water repellant/preservative. Do not use water repellant/preservatives on interior surfaces.

3.9 METAL SURFACES

Clean metal surfaces of foreign matter. Prepare metal in accordance with SSPC PA Guide 5. Remove grease, oil, and other soluble contaminants by solvent cleaning in accordance with SSPC SP 1. Surfaces must be free from soils and corrosion; e.g. grease, oil, solder flux, welding flux, weld spatter, sand, rust, scale, and other contaminants that might interfere with the application of the new finish. Gently clean to achieve the desired result. Do not abrasively clean metals which are soft, thin, or exhibit fine detail. Evidence of corrosion or contamination on a previously cleaned surface must be cause for recleaning prior to painting.

3.9.1 Ferrous Surfaces

Mechanically clean surfaces that contain loose rust, loose mill scale, and other foreign substances with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by blast cleaning according to [SSPC SP 5/NACE NO. 1], [SSPC SP 6/NACE NO.3], [SSPC 7/NACE NO.4], [SSPC SP 10/NACE NO. 2]. Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

3.9.2 Nonferrous Metallic Surfaces

Solvent-clean galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces in accordance with SSPC SP 1.

3.9.2.1 Zinc

Clean zinc surfaces including zinc-coated substrates prior to painting as follows: degrease, soak in a mild and inhibited alkaline cleaner, rinse with clean overflowing water, clean anodically in an acid (e.g. 0.25 to 0.75 percent sulfuric acid), and rinse with clean overflowing water.

3.10 TIMING

Give surfaces that have been cleaned, pretreated, and otherwise prepared for painting a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Unless otherwise directed, applythe first coat primer within 48 hours of surface preparation.

3.11 SURFACES TO BE PREPARED FOR PAINTING

Prepare surfaces as specified and as shown in the painting schedule in Section 09 90 00 PAINTS AND COATINGS.

3.12 CLEANING

Place cloths, cotton waste and other debris, that might constitute a fire hazard, in closed metal containers for removal at the end of each day. Remove containers from the site or destroy in an approved manner. Remove preparation materials and other deposits on adjacent surfaces and leave the entire job clean and ready for painting.

-- End of Section --

SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD 02/10, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C645	(2014; E 2015) Nonstructural Steel Framing Members
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C841	(2023) Installation of Interior Lathing and Furring
ASTM C847	(2014a) Standard Specification for Metal Lath

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM EMLA 920	(2009)	Guide	Specifications	for	Metal
	Lathing	g and	Furring		

UNDERWRITERS LABORATORIES (UL)

UL Fire Resistance (2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.] When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Support Systems; G[, [____]]

Submit for the erection of metal framing,. Indicate materials, sizes, thicknesses, and fastenings.

SD-03 Product Data

Metal Support Systems

Recycled Content for Metal Support Systems; S

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations permitting easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

- PART 2 PRODUCTS
- 2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating.

Provide metal support systems containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal support systems.

- 2.1.1 Materials for Attachment of Lath
- 2.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, and ASTM C847.

2.1.1.2 Non-load Bearing Wall Framing

NAAMM EMLA 920.

- 2.1.2 Materials for Attachment of Gypsum Wallboard
- 2.1.2.1 Suspended and Furred Ceiling Systems

ASTM C645.

2.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C645, but not thinner than[0.0179 inch thickness, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures][0.0329 inch thickness regardless of the ASTM certified third party testing statement for equivalent thicknesses].

2.1.2.3 Furring Structural Steel Columns

ASTM C645. Steel (furring) clips and support angles listed in UL Fire Resistance may be provided in lieu of steel studs for erection of gypsum wallboard around structural steel columns.

2.1.2.4 Z-Furring Channels with Wall Insulation

Not lighter than 26 gage galvanized steel, Z-shaped, with 1-1/4 inch and 3/4 inch flanges and [[1] [1 1/2] [2] [3] inch furring depth] [depth as required by the insulation thickness provided].

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Lath

3.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, except as indicated otherwise.

3.1.1.2 Non-load Bearing Wall Framing

NAAMM EMLA 920, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2 Systems for Attachment of Gypsum Wallboard

3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

3.1.2.3 Furring Structural Steel Columns

Install studs or galvanized steel clips and support angles for erection of gypsum wallboard around structural steel columns in accordance with the UL Fire Resistance, design number(s) [indicated] [of the fire resistance rating indicated].

3.1.2.4 Z-Furring Channels with Wall Insulation

Install Z-furring channels vertically spaced not more than 24 inches o.c. Locate Z-furring channels at interior and exterior corners in accordance with manufacturer's printed erection instructions. Fasten furring channels to masonry walls with powder-driven fasteners or hardened concrete steel nails through narrow flange of channel. Space fasteners not more than 24 inches o.c.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/4 inch in 8 feet from a straight line;

- c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

- a. Layout of walls and partitions: 1/4 inch from intended position;
- b. Plates and runners: 1/8 inch in 8 feet from a straight line;
- c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and
- d. Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

SECTION 09 24 23

CEMENT STUCCO 08/17, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM	A489	(2018; E 2018) Standard Specification for Carbon Steel Eyebolts
ASTM	A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM	A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM	A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM	A1008/A1008M	(2023) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM	A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM	B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM	C150/C150M	(2022) Standard Specification for Portland Cement
ASTM	C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM	C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM	C841	(2023) Installation of Interior Lathing and Furring
ASTM	C847	(2014a) Standard Specification for Metal

	Lath
ASTM C897	(2015; R 2020) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C926	(2023a) Standard Specification for Application of Portland Cement-Based Plaster
ASTM C933	(2014) Welded Wire Lath
ASTM C1032	(2014) Standard Specification for Woven Wire Plaster Base
ASTM C1063	(2023) Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lath

SD-03 Product Data

Proportions and Mixing

SD-04 Samples

Colored Stucco Finish Coat

Sample Panel; G[, [___]]

1.3 QUALITY ASSURANCE

Submit a SAMPLE PANEL as follows: A sample panel of stucco, constructed at the jobsite, and located as directed, to demonstrate installation

procedures, texture and color, prior to proceeding with any stucco work; panel size must be a minimum of 4 feet wide x 8 feet high; containing each type accessory proposed for use and constructed in the vertical position. Sample panel must have exposed reinforcement at the edges. Each phase of installation such as framing, scratch coat, brown coat, finish coat and curing procedures must be demonstrated in the construction of the panel. Submit one 12 inch square of reinforcement and one 12 inch length of each accessory proposed for use, prior to constructing the sample panel.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials to the site in the original packages and containers with labels intact and seals unbroken. Keep cementitious materials dry and stored off the ground, under cover and away from damp surfaces until ready to be used. Aggregate must be covered to prevent the absorption or loss of moisture.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not apply stucco when the ambient temperature is 40 degrees F or lower, or when a drop in temperature below 40 degrees F is expected within 48 hours after application.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

Portland cement must conform to ASTM C150/C150M, white Portland cement, Type [I] [II] [III].

2.2 COLORED STUCCO FINISH COAT

Colored stucco finish coat must be a mill mixed product using white Portland cement and requiring only the addition of and mixing with water for application. Color must match existing. Submit samples including both a fabricated portion of unit of work and color samples.

2.3 LIME

Lime must conform to ASTM C206, Type S.

2.4 SAND

Sand aggregate for job-mixed base coat and job-mixed finish coat stucco must conform to ASTM C897.

2.5 ACCESSORIES

Accessories must be roll formed galvanized steel, except that cornerite and striplath must be formed from steel sheets with manufacturer's standard galvanized coating. Vinyl members must be in accordance with ASTM D1784. Welded wire corner reinforcements must be zinc coated, galvanized 17 gauge steel wire conforming to ASTM A1064/A1064M. Furring must include hangers, bolts, inserts, clips, fastenings, and attachments of number, size, and design to develop the full strength of the members.

2.6 STEEL FRAMING

Steel framing must be as shown and must be manufacturer's standard products

with shop applied protective coating. Refer to Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD.

2.7 METAL LATH

Metal lath must conform to ASTM C847, types and weights in accordance with the various spacing shown in ASTM C841. Lath for vertical application on steel and wood framing supports must be expanded metal or welded or woven wire and must have paper backing with a minimum vapor permeance of 5 perms. Woven wire lath must be a maximum $1-1/2 \times 1-1/2$ inch mesh wire of not less than 0.0540 inch nominal diameter and must conform to ASTM C1032. Welded wire lath must conform to ASTM C933, with openings not to exceed 2 x 2 inches. Expanded metal or wire lath must be fabricated in a manner to provide not less than 1/4 inch keying between wire and paper backing and keying must be obtained by a uniform series of slots in a perforated face paper woven between the wires.

2.8 WATER

Provide clean, fresh, potable water, free from amounts of oils, acids, alkalis and organic matter that would be injurious to the stucco.

2.9 HANGERS

Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.9.1 Wires

Conform wires to [ASTM A641/A641M, Class 1, [0.08 inch (12 gauge)] [[____] inch] in diameter.][ASTM A580/A580M, composition 302 or 304, condition annealed stainless steel, [0.08 inch (12 gauge)] [[____] inch] in diameter.]

[2.9.2 Straps

Provide straps of 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

][2.9.3 Rods

Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

]2.9.4 Eyebolts

Provide eyebolts of weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A489. Eyebolt size must be a minimum [1/4] inch, [zinc coated][cadmium plated].

2.9.5 Masonry Anchorage Devices

Comply with [ASTM C636/C636M] [____] for anchorage devices for [eyebolts] [machine screws] [wood screws].

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.2 FRAMING

Framing must be installed as indicated.

3.3 CONTROL JOINTS

Locate control joints so that unbroken areas of stucco do not exceed 144 square feet with no dimension between control joints greater than 18 ft. Install prefabricated control joint members prior to the application of the stucco. Clear control joints of all stucco within the control area after stucco application and prior to final stucco set.

3.4 LATH

Install lath in accordance with ASTM C841 or ASTM C1063 except as otherwise specified. Metal and wire lath must be applied straight, without buckles and with joints staggered. End laps of metal lath must be not less than 1 inch. When paper-backed lath is used, the paper must be split from the lath at all lap areas to provide a paper to paper and lath to lath lap. Horizontal joints must be shiplapped. Lath must be interrupted at all control joints. Submit drawings showing details of construction for reinforcement, furring, and grounds; including manufacturer's installation instructions for stucco materials, and locations where each mix and coating thickness will be used.

3.4.1 Steel and Wood Supports

Apply metal lath over vertical open or solid wood and steel backing frame construction only after sheathing and air barrier has been applied to the area to receive the stucco. Fasten lath every 8 inches vertically and every 16 inches horizontally; and where sheets of lath are lapped. Drive fasteners to hold both lapped edges securely in place.

3.4.2 On Concrete and Masonry

Fasten lath every 8 inches vertically and every 16 inches horizontally. Where wood supports adjoin masonry or concrete in the same direction, provide casing bead, control joints, or reinforcement as indicated.

3.4.3 Over Metal Lintels and Flashings

Lath over metal lintels must be extended vertically over the angles to a height of not less than 6 inches and horizontally across the underside of the lintels and must be secured in an approved manner. Lath over metal flashings must lap the flashings not less than 2 inches and must be extended vertically for a height of not less than 6 inches.

3.4.4 Special Shapes, Profiles, and Contours

Special shapes, profiles, and contours must be formed with wood, metal or aluminum furring and reinforcing.

3.5 FURRING

Furring must be installed to true lines and surfaces and must be rigidly supported and secured in place.

3.6 PREPARATION OF SURFACES

Preparation of surfaces for application of stucco to solid bases such as stone, masonry or concrete must conform to the applicable requirements of ASTM C926.

3.7 PROPORTIONS AND MIXING

Proportions and mixing for job-mixed base coat and finish coat must conform to the applicable requirements of ASTM C926. Mixing of mill-mixed finish coat must be in accordance with the manufacturer's directions. Submit detailed description of the proposed job-mix proportions for base and finish coats; including identification of thickness of coats.

3.8 STUCCO APPLICATION

Stucco must be applied in three coats to a thickness of not less than 1 inch as measured from the back plane of metal reinforcement, exclusive of ribs or dimples or from the face of solid backing or support, with or without metal reinforcement, to the finished stucco surface, including moderate texture variations. Stucco application must conform to the applicable requirements of ASTM C926 and the following:

3.8.1 Workmanship

Items or features of the work in connection with or adjoining the stucco must be in place, plumb, straight, and true prior to beginning the stucco work. Metal and wire lath, where required, must be in place and positioned to provide a good key at back of lath. Where lath is applied over copper, the copper must be given a heavy coat of bituminous paint. Masonry surfaces to receive stucco must be evenly dampened immediately prior to application of stucco. Each stucco coat must be applied continuously in one general direction, without allowing mortar to dry at edges. Where it is impossible to work the full dimension of a wall surface in a continuous operation, jointing must be made at a break, opening, or other natural division of the surface. Edges to be joined must be dampened slightly to produce a smooth confluence. Exterior corners of stucco must be slightly rounded. Stucco on soffit surfaces must be pitched forward to form a drip.

3.8.2 Scratch Coat

Apply scratch coat not less than 3/8 inch thick under sufficient pressure to form good keys and to completely embed the reinforcement. Before the scratch coat has set, it must be lightly scratched in one direction and vertical surfaces must be scratched in the horizontal direction only. The scratch coat must be fog cured for a minimum of 72 hours.

3.8.3 Brown Coat

Evenly dampen the scratch coat to obtain uniform suction before the brown coat is applied. There must be no visible water on the surface when the brown coat is applied. The brown coat must be applied to the scratch coat with sufficient pressure to force the stucco into the scratches and must be brought to a plumb, true, even plane with rod or straightedge. When set

sufficiently, the brown coat must be uniformly floated with a dry float to promote densification of the coat and to provide a surface receptive to bonding of the finish coat. Brown coat must be fog cured for a minimum of 72 hours.

3.8.4 Finish Coat

Dampen surfaces of the brown coat not more than 1 hour before the finish coat is to be applied to a uniform wetness with no free-standing water on the surface. The finish coat must have a finish that matches the observed existing condition and must conform to the approved sample. Fog cure the finish coat for a minimum of 48 hours. Take care to prevent staining.

3.8.5 Surface Tolerance

When a 10 foot straightedge is placed at any location on the finished surface of the stucco, excluding rough-textured finish, the surface must not vary more than 1/8 inch from the straightedge.

3.9 CURING AND PROTECTION

Perform fog curing by applying a fine mist of water to the stucco. Exercise care during fog curing to avoid erosion damage of the stucco surfaces. Do not use a solid stream of water. Fog not less than three times daily. Protect the stucco from the direct rays of the sun during severe drying conditions using canvas, cloth or other approved sheet material.

3.10 PATCHING AND POINTING

Replace or patch loose, cracked, damaged or defective work as directed. Patching must match existing work in texture and color and must be finished flush.

-- End of Section --

SECTION 09 26 00

VENEER PLASTER 08/16, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C587	(2004; R 2014) Gypsum Veneer Plaster
ASTM C631	(2009; R 2020) Bonding Compounds for Interior Gypsum Plastering
ASTM C645	(2014; E 2015) Nonstructural Steel Framing Members
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C843	(2023) Standard Specification for Application of Gypsum Veneer Plaster
ASTM C844	(2015; R 2021; E 2021) Standard Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base

ASTM C1396/C1396M (2017) Standard Specification for Gypsum Board

1.2 GENERAL REQUIREMENTS

Except where otherwise indicated or specified, conform to ASTM C754, ASTM C843, and ASTM C844. Apply the gypsum veneer plaster as a [one coat] [two coat] system over a special gypsum base. The veneer plaster, gypsum base, and joint reinforcement must be products of the same manufacturer. The extent and location of veneer plaster must be as shown on the drawings. Metal framing is specified herein.[Wood framing specified in Section 06 10 00 ROUGH CARPENTRY may be used as an option to the steel framing.]

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Base

Gypsum Veneer Plaster

- [Recycled Content for Steel Framing or Furring; S
-] Descriptive data and installation instructions.

1.4 DELIVERY AND STORAGE

Deliver and store plaster materials in the manufacturer's original unopened containers. Store materials off the ground within a completely enclosed structure or enclosed within a weathertight covering. Store gypsum base and gypsum backing board flat to prevent warping and protect from excessive exposure to sunlight. Keep materials wrapped and separate from off-gassing materials, such as paint and adhesives. Do not use materials that have visible moisture or biological growth.

1.5 SCHEDULING

Commence application only after the area scheduled for veneer plaster work is completely weathertight. The heating, ventilating, and air-conditioning systems must be complete and in operation prior to application of the plaster. If the mechanical system cannot be activated before veneer plastering is begun, the plastering may proceed in accordance with an approved plan to maintain the environmental conditions specified below. Apply plaster prior to the installation of finish flooring and acoustic ceiling.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum base to excessive sunlight prior to plaster application, as bond failure of the plaster may result. Maintain a continuous uniform temperature of not less than 50 degrees F and not more

than 80 degrees F for at least one week prior to the application of veneer plaster, while the plastering is being done, and for at least one week after the plaster is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during plaster application, set, and until plaster is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Openings can be reduced in cold weather. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following plastering and until plaster is dry.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the requirements specified below. Miscellaneous items not otherwise specified must be as recommended by the veneer plaster system manufacturer and approved prior to use. Powder driven fasteners may be used only when approved in writing.

2.1.1 Steel Framing, Furring, and Related Items

ASTM C645.

2.1.2 Vapor Retarder

Foil-backed gypsum base or gypsum backing board, or 4-mil polyethylene.

2.1.3 Gypsum Backing Board

ASTM C1396/C1396M, Regular. Provide boards with square edges as the first ply in two-ply application. Provide 48 inches wide boards, thickness as shown except that board used for liner panels and core plies of shaftwall construction must be the size and thickness recommended by the system manufacturer.

2.1.4 Gypsum Base

ASTM C1396/C1396M, Regular, 48 inches wide, thickness as shown. Provide square edges, rounded, or tapered as recommended by the veneer plaster manufacturer.

2.1.5 Gypsum Veneer Plaster

ASTM C587. Minimum compressive strength of finish coat plaster must be 2500 psi.

2.1.6 Joint Reinforcement

ASTM C475/C475M, Mesh reinforcing strip or paper tape as recommended by the veneer plaster manufacturer.

2.1.7 Joint Compound

ASTM C475/C475M.

2.1.8 Screws

ASTM C1002or ASTM C954, type appropriate to use.

2.1.9 Nails

ASTM C514, with corrosion-resistant treatment.

2.1.10 Corner Bead, Casing Bead, and Control Joints

ASTM C1047 , Corrosion protective-coated steel as recommended by the veneer plaster manufacturer. Provide flanges free of any material that would adversely affect bonding of the plaster.

PART 3 EXECUTION

3.1 STEEL FRAMING

ASTM C754. Space framing at 16 inches on center maximum. Partitions must support applied loads such as cabinets and counters without exceeding the permitted deflection.

3.1.1 Partition Framing System

Metal non-load bearing framing and furring system must be capable of carrying a transverse load of 5 psf without exceeding either the allowable stress or a deflection of L/240. Provide studs of 0.0179 inch minimum thickness for partitions having the same material and the same material thickness on both sides. For partitions using 0.0179 inch thick studs, the surfacing material must cover the full height of the partition on both sides, or the stud flange must be otherwise supported to insure rigidity. Provide studs of 0.0329 inch minimum thickness for partitions having different materials or different material thickness on the two sides. At partition ends, corners, and intersections, and at jambs of openings, fasten studs to runners with screws.

3.1.2 Special Framing

Build framing for beams, columns, soffits, and other special items to the sizes, shapes, or forms indicated. Secure rigidly at each intersection with screws.

3.1.3 Shaftwall Framing System

Shaftwalls must be standard, tested designs. Metal framing must be in accordance with the shaftwall manufacturer's printed instructions.

3.1.4 Ceiling Openings

Provide support members at ceiling openings such as required for access panels, recessed light fixtures, and for air supply or exhaust. Locate support members of not less than 1 1/2 inch main runner channels and suspension wires or straps to provide at least the minimum support specified herein for furring and wallboard attachment. Provide intermediate structural members for attachment or suspension of support members.

3.1.5 Wall Openings

At wall openings the framing system must provide for the installation and anchorage of the required subframes or finish frames. Attach steel frames securely through built-in anchors to the nearest stud on each side of the opening with wallboard screws. Provide 0.329 inch minimum thickness double studs at both jambs of all doors openings. For doors over 4 feet wide, double doors, and for extra-heavy doors (such as x-ray doors), provide doubled studs 3 inches minimum thickness. Spot grout door frames at the jamb anchor locations with joint compound applied just prior to application of gypsum base.

3.1.6 Blocking

Provide blocking when mounting equipment. Cut metal blocking to fit in between the framing members. Rigidly anchor blocking to the framing members. Under no circumstances will accessories or other wall mounted equipment be anchored directly to the veneer plaster system.

3.2 APPLICATION OF GYPSUM BASE

Apply gypsum base and gypsum backing board to framing and furring members in accordance with ASTM C844 and the requirements specified herein. Gypsum wallboard may be used for the base ply in two-ply construction. Provide gypsum base and backing board of maximum practical length, using full length boards for vertical application. Install separate boards in moderate contact without forcing in place. Install boards tight against the framing so as to eliminate any offset in the face plane between adjoining boards. Stagger end joints of adjoining boards. Fit abutting end and edge joints. Cut boards as required to make close joints around openings. Gypsum base may be adhered to gypsum backing board with an adhesive, except where prohibited by fire rating. In multi-layer construction, offset joints between layers. Offset joints on opposite faces of the partition.

3.2.1 Curved Surfaces

Use bending radii in accordance with ASTM C844, TABLE 5. Bend gypsum base into place without damaging the face paper. If the base is dampened to facilitate bending, dry thoroughly, and apply a bonding agent (ASTM C631) before plastering.

3.2.2 Cavity Shaftwall System

Install gypsum backing boards, core boards, and gypsum base in accordance with the shaftwall system manufacturer's printed recommendations to achieve the fire rating required.

3.2.3 Control Joints

Control joints in ceilings and walls must be one piece manufactured products designed for use with a veneer plaster system.

3.2.4 Vapor Retarder

Install foil-backed gypsum base or gypsum backing board with the reflective surface against the framing members. Install polyethylene vapor retarder with joints over framing members, and with joints lapped the full width of the framing members.

3.3 JOINT REINFORCEMENT

Reinforce all interior angles and flat joints prior to application of the veneer plaster. Do not use self-adhering fiberglass mesh tape. Reinforcement must be a special mesh reinforcing strip embedded in veneer plaster, or paper gypsum wallboard tape embedded in joint compound.

3.3.1 Paper Tape Reinforcing

Press the paper tape into a bedding coat of setting type joint compound, and immediately cover with a skim coat of the same compound. After the bedding and skim coats are set, apply a fill coat of joint compound. Set the reinforcement and dry thoroughly before application of veneer plaster.

3.4 APPLICATION OF GYPSUM VENEER PLASTER

Apply gypsum veneer plaster in accordance with ASTM C843, and with the manufacturer's approved installation instructions where such instructions are additional to or more restrictive than the requirements of ASTM C843. Apply plaster as a two-component system. Minimum plaster thickness must be as recommended by the manufacturer, but must in no case be less than1/16 inch for base coat and 1/32 inch for finish coat of a two-component system.

3.4.1 Mixing

Clean mixer between batches to avoid accelerating the setting time. Do not add other plaster materials to modify the properties of the veneer plaster. When extreme conditions so demand, small quantities of commercial retarder or accelerator may be added to the mixing water to adjust setting time. When used, the retarder or accelerator must conform to the veneer plaster manufacturer's recommendations.

3.4.2 Application

Trowel plaster on by hand. Apply with sufficient material and pressure to develop bond and to provide the specified component thickness.

3.4.2.1 Base Coat

Scratch in the base coat tightly, then immediately double back using material from the same batch. Fill all voids and imperfections and level the plaster to a true surface without the application of water. For good bond or adhesion, roughen the final surface for bond by brushing or cross-raking with a fine wire rake. For application of finish coat, set the base coat and partially dry. If the base coat is totally dry, dampen before finish coat application.

3.4.2.2 Finish Coat

Scratch in the finish coat tightly, then immediately double back using material from the same batch. After the plaster has been allowed to set up slightly, lightly trowel the surface without the addition of water, filling all voids and imperfections and eliminating surface irregularities. When the plaster has become firm and prior to set, smooth-trowel the surface

using water sparingly. Avoid over troweling.

3.5 CLEANUP AND PATCHING

Remove plaster splashes from adjacent surfaces. Repair defects in the veneer plaster. Plaster surfaces must be smooth, clean, and in condition to receive the finishing materials that will be applied.

-- End of Section --
SECTION 09 29 00

GYPSUM BOARD 08/16, CHG 4: 02/20

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for
	Interior Installation of Cementitious
	Backer Units

ASTM INTERNATIONAL (ASTM)

ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C557	(2003; R 2017) Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing
ASTM C840	(2023) Standard Specification for Application and Finishing of Gypsum Board
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1396/C1396M	(2017) Standard Specification for Gypsum Board
ASTM C1629/C1629M	(2023) Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels

ASTM D1037	(2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D2394	(2017) Standard Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM D3273	(2021) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM D5420	(2016) Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E695	(2022) Standard Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
CALIFORNIA DEPARTMENT O	F PUBLIC HEALTH (CDPH)
CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers
FM GLOBAL (FM)	
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
GREEN SEAL (GS)	
GS-36	(2013) Adhesives for Commercial Use
GYPSUM ASSOCIATION (GA)	
GA 214	(2010) Recommended Levels of Gypsum Board Finish
GA 216	(2016) Application and Finishing of Gypsum Panel Products
SOUTH COAST AIR QUALITY	MANAGEMENT DISTRICT (SCAQMD)
SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications
UNDERWRITERS LABORATORI	ES (UL)
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

UL Fire Resistance (2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cementitious Backer Units

Glass Mat Water-Resistant Gypsum Tile Backing Board

Water-Resistant Gypsum Backing Board

[Abuse Resistant Gypsum Board

] Accessories

Submit for each type of gypsum board and for cementitious backer units.

Gypsum Board

VOC Content of Joint Compound; S

SD-04 Samples

Predecorated Gypsum Board; G[, []]

Submit for each color and pattern of predecorated gypsum board. Where colors are not indicated, submit color selection samples of not less than eight of the manufacturer's standard colors.

SD-06 Test Reports

ASTM E90 Factory Test Report; G[, []]

ASTM E336 Field Test Report; G[, []]

SD-07 Certificates

Asbestos Free Materials; G[, []]

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

Indoor Air Quality for Gypsum Board; S

Indoor Air Quality for Non-aerosol Adhesives; S

Indoor Air Quality for Aerosol Adhesives; S

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.3.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.4.1 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.

1.4.2 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. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth.

1.4.3 Handling

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

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of [3] [____] years of documented successful experience.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking

natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

[1.7 FIRE RESISTIVE CONSTRUCTION

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

-]PART 2 PRODUCTS
- 2.1 MATERIALS

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

2.1.1 Gypsum Board

ASTM C1396/C1396M. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.1.1.1 Regular

48 inch wide, 1/2 inch thick, tapered edges.

2.1.1.2 Mold Resistant / Anti-Microbial Gypsum

ASTM D3273. 48 inch wide, 1/2 inch thick, tapered edges.

2.1.2 Gypsum Backing Board

ASTM C1396/C1396M, gypsum backing board must be used as a base in a multilayer system.

2.1.2.1 Regular

48 inch wide, 1/2 inch thick, square edges.

2.1.3 Regular Water-Resistant Gypsum Backing Board

ASTM C1396/C1396M

2.1.3.1 Regular

48 inch wide, 1/2 inch thick, tapered edges.

[][2.1.4 Abuse Resistant Gypsum Board

48 inch wide, 5/8 inch thick, tapered edges. Reinforced gypsum panel with imbedded fiber mesh or lexan backing tested in accordance with the following tests. Hard body impact test must attain a Level 2 performance in accordance with ASTM C1629/C1629M. Provide fasteners that meet manufacturer requirements and specifications stated

within this section. Abuse resistant gypsum board, when tested in accordance with ASTM E84, have a flame spread rating of 25 or less and a smoke developed rating of 50 or less for [___]] [and] [a flame spread rating of 75 or less and a smoke developed rating of 100 or less for [__]].

2.1.4.1 Soft Body Impact Test

ASTM E695 or ASTM D2394 for impact penetration and deformation. ASTM E695 using a 60 lb leather bag filled with steel pellets, resisting no less than 300 ft. lb. cumulative impact energy before failure or ASTM D2394 using 5.5 inch hemispherical projectile resisting no less than 264 ft. lb. before failure. Provide test specimen stud spacing a minimum 16 inch on center.

2.1.4.2 Hard Body Impact Test

Comply with hard body impact test in accordance with ASTM C1629/C1629M Classification Level 2.

2.1.4.3 Surface Abrasion Test

Comply with test surface abrasion test in accordance with ASTM C1629/C1629M.

2.1.4.4 Indentation Test

ASTM D5420 or ASTM D1037 for indentation resistance. ASTM D5420 using a 32 oz weight with a 5/8 inch hemispherical impacting head dropped once 3 feet creating not more than 0.137 inch indentation or ASTM D1037 using no less than 470 lb weight applied to the 0.438 inch diameter ball to create not more than a 0.0197 inch indentation depth.

]2.1.5 Cementitious Backer Units

In accordance with the Tile Council of America (TCA) Handbook.

2.1.6 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Provide data identifying VOC content of joint compound.

2.1.6.1 Embedding Compound

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

2.1.6.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.6.3 All-Purpose Compound

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

2.1.6.4 Setting or Hardening Type Compound

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

2.1.6.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

- 2.1.7 Fasteners
- 2.1.7.1 Nails

ASTM C514.

2.1.7.2 Screws

ASTM C1002, 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 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.7.3 Staples

No. 16 USS gage flattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

Length of Legs	Thickness of Gypsum Board
1-1/8 inches	1/2 inch
1-1/4 inches	5/8 inch

2.1.8 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.1.8.1 Adhesive for Fastening Gypsum Board to Metal Framing

Type recommended by gypsum board manufacturer.

2.1.8.2 Adhesive for Fastening Gypsum Board to Wood Framing

ASTM C557.

2.1.9 Gypsum Studs

Provide one inch minimum thickness and 6 inch minimum width. Studs may be

of one inch thick gypsum board or multilayers fastened to required thickness. Conform to ASTM C1396/C1396M for material and GA 216 for installation.

2.1.10 Accessories

ASTM C1047. Fabricate from corrosion protected steel designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

2.1.11 Water

Provide clean, fresh, and potable water.

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 Gypsum Board and Framing

Verify that surfaces of gypsum board and framing to be bonded with an adhesive are free of dust, dirt, grease, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.3 Masonry Walls

Verify that surfaces of masonry 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.

3.1.4 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified. 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; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight 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. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may [not]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 Single-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System I or GA 216.

3.2.2 Application of Two-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System II or GA 216.

3.2.3 Adhesive Nail-On Application to Wood Framing

Apply in accordance with ASTM C840, System III or GA 216. This method may be used in lieu of ASTM C840, System I at the option of the Contractor.

3.2.4 Semi-Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System IV or GA 216 .

3.2.5 Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System V or GA 216.

3.2.6 Adhesive Application to Interior Masonry or Concrete Walls

Apply in accordance with ASTM C840, System VI or GA 216.

3.2.7 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.8 Arches and Bending Radii

Apply gypsum board in accordance with ASTM C840, System IX or GA 216.

3.2.9 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 mat water-resistant gypsum tile backing board [or water-resistant gypsum backing board] in accordance with ASTM C840, System X or GA 216.

3.2.10 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216.

3.2.11 Application of Abuse Resistant Gypsum Board

Apply in accordance with applicable system of ASTM C840 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. Place a 15 lb asphalt impregnated, continuous felt paper membrane behind cementitious backer units, between backer units and studs or base layer of gypsum board. Place membrane with a minimum 6 inch overlap of sheets laid shingle style.

3.3.2 Joint Treatment

ANSI A108.11.

3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish water resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use self-adhering 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. Protect workers, building occupants, and HVAC systems from gypsum dust.

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 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

]3.6 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes. [Remove predecorated gypsum board which cannot be restored to like-new condition. Provide new predecorated gypsum board.]

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[] -- End of Section --
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SECTION 09 64 29

WOOD STRIP AND PLANK FLOORING 08/16, CHG 2: 11/18

PART 1 GENERAL

1.1 SUMMARY

This specification is written to allow the Contractor to build wood strip floorings for gymnasiums, handball and squash courts, and other special purpose applications but does not preclude the installation of competitive, manufacturer standard, integrated systems.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Strip Flooring; G[, [____]]

SD-03 Product Data

Strip Flooring

Installation

SD-04 Samples

Strip And Plank Flooring

1.3 CERTIFICATIONS

[]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site in original unopened packages, bundles or containers and with all labels intact. Store flooring in fully covered, well ventilated areas protected from extreme changes in temperature and humidity. Maintain flooring at an average moisture content of 6 to 9 percent. Temperature and humidity in the storage area must closely approximate the temperature and humidity of the rooms in which the flooring is to be installed.

1.5 ENVIRONMENTAL REQUIREMENTS

Provide permanent heating and air conditioning, installed and working, in rooms where wood flooring is to be installed or adequate arrangements for ventilation and temperature controls. Maintain the temperature at 55 to 80 degrees F and maintain the humidity as recommended by the manufacturer starting not less than 3 days prior to beginning the installation of flooring and continuing throughout the remainder of the contract period.

1.6 SCHEDULING

Schedule strip and plank flooring work after any other work which would raise the moisture content of the flooring or damage the finished surface of the flooring.

PART 2 PRODUCTS

2.1 STRIP FLOORING

2.1.1 General Requirements

Strip and plank flooring must be 3/4 inch thick by 2-1/4 inch face width, kiln dried, continuous tongue and groove and of standard lengths. Provide reclaimed, long-leaf southern yellow pine elements unless otherwise specified. Provide wood products with no added urea-formaldehyde resins. Strip flooring must be marked with the trademark of the grading agency. Submit two samples of each type of strip and plank flooring.

]

[]2.2 NAILS

Provide nails in accordance with strip flooring manufacturer's recommendations.

2.3 RESILIENT PADS

Resilient pads must be pneumatic rubber, PVC, or polyurethane resilient mounts to fit the selected floor system.

2.4 WALL BASE

Wall base must be wood molding or vented cove with premolded outside corners and mitered inside corners.

2.5 MOISTURE BARRIER

Moisture barrier must be 6 mil minimum thickness polyethylene.

2.6 CLIPS, ANCHOR CHANNELS AND INSULATION

Galvanized steel clips for steel channel anchorage systems must be in accordance with steel channel anchorage system manufacturer's recommendations. Clips must be designed to provide holding at least equal to the nailing specified and must function without splitting the assembled boards or otherwise reducing the performance of the floor. Anchor channels must be as recommended by the flooring manufacturer. Anchor channels must be galvanized, complete with all pads, anchors and other components required for channel installation. Underfloor insulation must be asphalt

impregnated fiberboard or closed-cell polyethylene foam.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

Ensure that joist system is clean, dry, and approved prior to start of installation.

3.2 INSTALLATION

Install flooring in accordance with the approved installation instructions of the manufacturer. Submit manufacturer's descriptive data and installation instructions. Wood nailers are specified in Section 06 10 00 ROUGH CARPENTRY. Unless otherwise approved, flooring must be laid parallel to the length of the area to be floored. Strips must be laid with close joints, snugly driven up but providing for absorption of a small amount of expansion, and double-nailed. End joints must be so alternated that there will be at least two boards between end joints in the same plane and at least 6 inches between end joints in adjacent boards. Space for expansion must be left along perimeter walls and around fixed projections through the floor surface. Unless otherwise shown or permitted by the approved installation instructions, expansion space must be 1/16 inch per foot of distance between opposite walls, with one half the space provided at each wall and with a minimum space of 1 inch at each wall.

Do not install building construction materials that show visual evidence of biological growth.

3.3 SANDING

Sand flooring to a smooth, even, uniform finish without burns. Make a minimum of three sanding cuts, each with a finer sandpaper. Use a heavy drum-type sander for floors, except a disc-type sander is permitted for the final cut on strip flooring. Either the first pass or the second pass of the drum-type sander must be at an angle of 45 degrees to the grain; other passes of the drum-type sander must be in the direction of the grain of strip flooring. Finish edges not reached by the sander with an edger or by hand methods. Perform the final sanding at a time and in a manner that will permit application of the first seal coat as specified in Section 09 90 00 PAINTS AND COATINGS to be completed within 8 hours after completion of sanding. Leave the flooring clean and ready to receive the finishing materials.

3.4 PROTECTION

Protect flooring from damage from the time of installation until final acceptance.

-- End of Section --

SECTION 09 90 00

PAINTS AND COATINGS 02/21

PART 1 GENERAL

- 1.1 RELATED REQUIREMENTS
- 1.1.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

- a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.
- b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.
- c. Existing coated surfaces that are damaged during performance of the work.
- 1.1.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the building and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.1.1.2 Interior Painting

Includes new surfaces, existing uncoated surfaces, and existing coated surfaces of the building and appurtenances as indicated and existing coated surfaces made bare by cleaning operations.

1.1.2 Painting Excluded

Do not paint the following unless indicated otherwise.

- a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.
- b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.
- c. Steel to be embedded in concrete.
- d. Copper, stainless steel, aluminum, anodized aluminum, brass, and lead except existing coated surfaces.
- e. Hardware, fittings, and other factory finished items.

]1.1.3 Mechanical and Electrical Painting

Includes field coating of interior new and existing surfaces.

- a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.
 - (1) Exposed piping, conduit, and ductwork;
 - (2) Supports, hangers, air grilles, and registers;
 - (3) Miscellaneous metalwork and insulation coverings.

1.2 REFERENCES

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100 (2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2023)	Scheme	for	the	Identification	of
	Piping	Systems	5			

ASTM INTERNATIONAL (ASTM)

ASTM	C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM	D235	(2002; R 2012) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM	D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM	D2824/D2824M	(2018) Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, and Fibered without Asbestos
ASTM	D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM	D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM	D4444	(2013; R 2018) Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters
ASTM	D6386	(2016a) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

ASTM F1869

(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

Intelligence Bulletin 65 (2013) Occupational Exposure to Carbon Nanotubes and Nanofibers

MASTER PAINTERS INSTITUTE (MPI)

MPI	1	(2012) Aluminum Paint
MPI	2	(2012) Aluminum Heat Resistant Enamel (up to 427 C and 800 F
MPI	3	(2016) Primer, Alkali Resistant, Water Based
MPI	4	(2016) Interior/Exterior Latex Block Filler
MPI	5	(2015) Primer, Exterior Alkyd Wood
MPI	6	(2015) Primer, Exterior Latex Wood
MPI	8	(2016) Alkyd, Exterior Flat (MPI Gloss Level I)
MPI	9	(2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)
MPI	10	(2016) Latex, Exterior Flat (MPI Gloss Level 1)
MPI	11	(2016) Latex, Exterior Semi-Gloss, MPI Gloss Level 5
MPI	13	(2016) Stain, Exterior Solvent-Based, Semi-Transparent
MPI	16	(2016) Stain, Exterior, Water Based, Solid Hide
MPI	17	(2016) Primer, Bonding, Water Based
MPI	19	(2012) Primer, Zinc Rich, Inorganic
MPI	21	(2012) Heat Resistant Coating, (Up to 205°C/402°F), MPI Gloss Level 6
MPI	22	(2012) Aluminum Paint, High Heat (up to 590° C/1100° F)
MPI	23	(2015) Primer, Metal, Surface Tolerant
MPI	27	(2016) Floor Enamel, Alkyd, Gloss (MPI Gloss Level 6)
MPI	31	(2012) Varnish, Polyurethane, Moisture

	Cured, Gloss (MPI Gloss Level 6)
MPI 39	(2018) Primer, Latex, for Interior Wood
MPI 42	(2012) Textured Coating, Latex, Flat
MPI 44	(2016) Latex, Interior, (MPI Gloss Level 2)
MPI 45	(2016) Primer Sealer, Interior Alkyd
MPI 46	(2016) Undercoat, Enamel, Interior
MPI 47	(2016) Alkyd, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 48	(2016) Alkyd, Interior, Gloss (MPI Gloss Level 6-7)
MPI 49	(2015) Alkyd, Interior, Flat (MPI Gloss Level 1)
MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 51	(2016) Alkyd, Interior, (MPI Gloss Level 3)2
MPI 52	(2016) Latex, Interior, (MPI Gloss Level 3)
MPI 54	(2016) Latex, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 56	(2012) Varnish, Interior, Polyurethane, Oil Modified, Gloss
MPI 57	(2012) Varnish, Interior, Polyurethane, Oil Modified, Satin
MPI 59	(2016) Floor Paint, Alkyd, Low Gloss
MPI 60	(2016) Floor Paint, Latex, Low Gloss
MPI 68	(2016) Floor Paint, Latex, Gloss
MPI 71	(2012) Varnish, Polyurethane, Moisture Cured, Flat (MPI Gloss Level 1)
MPI 72	(2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)
MPI 76	(2016) Primer, Alkyd, Quick Dry, for Metal
MPI 77	(2015) Epoxy, Gloss
MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal
MPI 90	(2012) Stain, Semi-Transparent, for Interior Wood

MPI 94	(2016) Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5)
MPI 95	(2015) Primer, Quick Dry, for Aluminum
MPI 101	(2016) Primer, Epoxy, Anti-Corrosive, for Metal
MPI 107	(2016) Primer, Rust-Inhibitive, Water Based
MPI 108	(2015) Epoxy, High Build, Low Gloss
MPI 116	(2012) Block Filler, Epoxy
MPI 119	(2016) Latex, Exterior, Gloss (MPI Gloss Level 6)
MPI 134	(2015) Primer, Galvanized, Water Based
MPI 138	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 2)
MPI 139	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 3)
MPI 140	(2016) Latex, Interior, High Performance Architectural, (MPI Gloss Level 4)
MPI 141	(2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5)
MPI 144	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 2)
MPI 145	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)
MPI 146	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 4)
MPI 147	(May 2016) Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (MPI Gloss Level 5)
MPI 149	(2016) Primer Sealer, Interior, Institutional Low Odor/VOC
MPI 151	(2016) Light Industrial Coating, Interior, Water Based (MPI Gloss Level 3)
MPI 153	(2016) Light Industrial Coating, Interior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 154	(2016) Light Industrial Coating, Interior, Water Based, Gloss (MPI Gloss Level 6)
MPI 161	(2016) Light Industrial Coating, Exterior, Water Based (MPI Gloss Level 3)

MPI 163	(2016) Light Industrial Coating, Exterior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 164	(2016) Light Industrial Coating, Exterior, Water Based, Gloss (MPI Gloss Level 6)
MPI ASM	(2019) Architectural Painting Specification Manual
MPI GPS-1-14	(2014) Green Performance Standard GPS-1-14
MPI GPS-2-14	(2014) Green Performance Standard GPS-2-14
MPI MRM	(2015) Maintenance Repainting Manual
SOCIETY FOR PROTECTIVE	COATINGS (SSPC)
SSPC 7/NACE No.4	(2007) Brush-Off Blast Cleaning
SSPC Glossary	(2011) SSPC Protective Coatings Glossary
SSPC Guide 6	(2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 7	(2015) Guide to the Disposal of Lead-Contaminated Surface Preparation Debris
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2018) Hand Tool Cleaning
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning
SSPC-SP WJ-2/NACE WJ-2	(2012) Very Thorough Cleaning, Waterjet Cleaning of Metals
SSPC-SP WJ-3/NACE WJ-3	(2012) Thorough Cleaning, Waterjet Cleaning of Metals

100% DESIGN SUBMISSION SSPC-SP WJ-4/NACE WJ-4 (2012) Light Cleaning, Waterjet Cleaning of Metals SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE) SAE AMS-STD-595A (2017) Colors used in Government Procurement U.S. ARMY CORPS OF ENGINEERS (USACE) EM 385-1-1 (2014) Safety -- Safety and Health Requirements Manual U.S. DEPARTMENT OF DEFENSE (DOD) MIL-STD-101 (2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) EPA Method 24 (2000) Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings U.S. GENERAL SERVICES ADMINISTRATION (GSA) FED-STD-313 (2018) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA) 29 CFR 1910.1000 Air Contaminants 29 CFR 1910.1001 Asbestos 29 CFR 1910.1025 Lead 29 CFR 1926.62 Lead

1.3 DEFINITIONS

1.3.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third-party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.3.2 Batch Quality Conformance Testing

REPAIR AND RENOVATION MATTHEW JONES HOUSE

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing must be accomplished by an MPI testing lab.

1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the Assessment sections in the MPI MRM, MPI Maintenance Repainting Manual.

1.3.6 EXT

MPI short term designation for an exterior coating system.

1.3.7 INT

MPI short term designation for an interior coating system.

1.3.8 Loose Paint

Paint or coating that can be removed with a dull putty knife.

1.3.9 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

1.3.10 MPI Gloss Levels

MPI system of defining gloss. Seven gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60	Units at 80
		degree angle	degree angle
G1	Matte or Flat	0 to 5	10 max
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	

Gloss Level	Description	Units at 60	Units at 80
		degree angle	degree angle
G7	High Gloss		

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.3.11 MPI System Number

The MPI coating system number in each MPI Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN).

1.3.12 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

1.3.13 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.3.14 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-02 Shop Drawings

Piping Identification

SD-03 Product Data

Coating; G[, [____]]

Product Data Sheets

Sealant

SD-04 Samples

Color; G[, [____]]

Textured Wall Coating System; G[, [____]]

[Sample Textured Wall Coating System Mock-Up; G[, []]

] SD-07 Certificates

Qualification Testing laboratory for coatings; G[, []]

Indoor Air Quality for Paints and Primers

SD-08 Manufacturer's Instructions

Application Instructions

Mixing

Manufacturer's Safety Data Sheets

SD-10 Operation and Maintenance Data

Coatings, Data Package 1; G[, []]

1.5 QUALITY ASSURANCE

- 1.5.1 Regulatory Requirements
- 1.5.1.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.5.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.1.4 Asbestos Content

Provide asbestos-free materials.

1.5.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.5.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.5.1.7 Human Carcinogens

Provide materials that do not contain $\ensuremath{\mathsf{ACGIH}}$ 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.5.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

1.5.2 Coating Contractor's Qualification

Submit the name, address, telephone number, and e-mail address of the Contractor that will be performing all surface preparation and coating application. Submit evidence that key personnel have successfully performed surface preparation and application of coatings on [___] on a minimum of three similar projects within the past three years. List information by individual and include the following:

- a. Name of individual and proposed position for this work.
- b. Information about each previous assignment including:

Position or responsibility Employer (if other than the Contractor) Name of facility owner Mailing address and telephone number of facility owner Name of individual in facility owner's organization who can be contacted as a reference Location, size and description of structure Dates work was carried out

Description of work carried out on structure

1.5.3 SSPC QP 1 Certification

Contractors that perform surface preparation or coating application on steel substrates must be certified by the Society for Protective Coatings (formerly Steel Structures Painting Council) (SSPC) to the requirements of SSPC QP 1 prior to Contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from SSPC and furnish a copy of all audit reports.

1.5.4 Approved Products List

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of Contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire Contract

and each coating system is to be from a single manufacturer. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

1.5.5 Paints and Coatings Indoor Air Quality Certifications

Provide paint and coating products certified to meet indoor air quality requirements by MPI GPS-1-14, MPI GPS-2-14 or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of Indoor Air Quality for Paints and Primers. [Provide certification of Indoor Air Quality for Consolidated Latex Paints.]Submit required indoor air quality certifications in one submittal package.

1.5.6 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph SAMPLING PROCEDURE. Test each chosen product as specified in the paragraph TESTING PROCEDURE. Remove products from the job site which do not conform, and replace with new products that conform to the referenced specification. Test replacement products that failed initial testing as specified in the paragraph TESTING PROCEDURE at no cost to the Government.

1.5.6.1 Sampling Procedure

Select paint at random from the products that have been delivered to the job site for sample testing. The Contractor must provide one quart samples of the selected paint materials. Take samples in the presence of the Contracting Officer, and label, and identify each sample. Provide labels in accordance with the paragraph PACKAGING, LABELING, AND STORAGE.

1.5.6.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph QUALIFICATION TESTING laboratory for coatings. Include the backup data and summary of the test results within the qualification testing lab report. Provide a summary listing of all the reference specification requirements and the result of each test. Clearly indicate in the summary whether the tested paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If MPI is chosen to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

1.5.7 Textured Wall Coating System

Three complete samples of each indicated type, pattern, and color of textured wall coating system applied to a panel of the same material as that on which the coating system will be applied in the work. Provide samples of wall coating systems minimum 5 by 7 inches and of sufficient size to show pattern repeat and texture.

1.5.8 Sample Textured Wall Coating System Mock-Up

After coating samples are approved and prior to starting installation, provide a minimum 8 foot by 8 foot mock-up for each substrate and for each color and type of textured wall coating using the actual substrate materials. Use the approved mock-up samples as a standard of workmanship for installation within the facility. Submit at least 48 hour advance written notice to the Contracting Officer's Representative prior to mock-up installation.

]1.6 PACKAGING, LABELING, AND STORAGE

Provide paints in sealed containers that legibly show the Contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than 5 gallons. Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

1.7 SAFETY AND HEALTH

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.7.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.
- b. 29 CFR 1910.1000.
- c. ACGIH 0100, threshold limit values.
- d. The appropriate OSHA standard in 29 CFR 1910.1025 and 29 CFR 1926.62 for surface preparation on painted surfaces containing lead. Removal and disposal of coatings which contain lead is specified in Section 02 83 00 LEAD REMEDIATION. Additional guidance is given in SSPC Guide 6 and SSPC Guide 7. Refer to drawings for list of hazardous materials located on this project. Coordinate paint preparation activities with this specification section.

e. The appropriate OSHA standards in 29 CFR 1910.1001 for surface preparation of painted surfaces containing asbestos. Removal and disposal of coatings which contain asbestos materials is specified in Section 02 82 00 ASBESTOS REMEDIATION. Refer to drawings for list of hazardous materials located on this project. Coordinate paint preparation activities with this specification section.

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

1.8 ENVIRONMENTAL REQUIREMENTS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high-emission paints or coatings.

1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit Product Data Sheets for specified coatings and solvents. Provide preprinted cleaning and maintenance instructions for all coating systems. Submit Manufacturer's Instructions on Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, pot life, and curing and drying times between coats.

[2.2 COLOR CODING FOR SHORE-TO SHIP UTILITY CONNECTIONS

Color Coding For Shore-To-Ship Utility Connections: Paint hose connection fittings and shut-off valves the designated color. In addition to color coding provide 2 inch high stenciled letters using black stencil paint, clearly designating service for each connection.

Color Coding for Shore-to-Ship			
Utility Connections			
Service	Color	SAE AMS-STD-595A No.	
Potable Water*	Blue	15044	
Water Provided for Fire Protection**	Red	11105	
Chilled Water	Striped Blue/White	15044 / 17886	

Color Coding for Shore-to-Ship			
Oily Waste Water	Striped Yellow/Black	13528 / 17038	
Sewer	Gold	17043	
Steam	White	17886	
High Pressure Air	Gray	16081	
Low Pressure Air	Tan	10324	
Fuels	Yellow	13655	
* This includes connections serving domestic functions.			

** This includes non-potable salt water or, at some locations, fresh water connections provided for fire protection (may also include flushing and cooling requirements). Note: This does not include waterfront fire hydrants.

]2.3 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

Provide color, texture, and pattern of wall coating systems [as indicated in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

[3.2 REPUTTYING AND REGLAZING

Remove cracked, loose, and defective putty or glazing compound on glazed sash and provide new putty or glazing compound. Where defective putty or glazing compound constitutes 30 percent or more of the putty at any one light, remove the glass and putty or glazing compound and reset the glass. Remove putty or glazing compound without damaging sash or glass. Clean rabbets to bare wood or metal and prime prior to reglazing. Provide linseed oil putty for wood sash. Patch surfaces to provide smooth

transition between existing and new surfaces. Finish putty or glazing compound to a neat and true bead. Allow glazing compound time to cure, in accordance with manufacturer's recommendation, prior to coating application. Allow putty to set one week prior to coating application.

3.3 RESEALING OF EXISTING EXTERIOR JOINTS

3.3.1 Surface Condition

Begin with surfaces that are clean, dry to the touch, and free from frost and moisture; remove grease, oil, wax, lacquer, paint, defective backstop, or other foreign matter that would prevent or impair adhesion. Where adequate grooves have not been provided, clean out to a depth of 1/2 inch and grind to a minimum width of 1/4 inch without damage to adjoining work. Grinding is not required on metal surfaces.

3.3.2 Backstops

In joints more than 1/2 inch deep, install glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free of oil or other staining elements as recommended by sealant manufacturer. Provide backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

3.3.3 Primer and Bond Breaker

Install the type recommended by the sealant manufacturer.

3.3.4 Ambient Temperature

Between 38 degrees F and 95 degrees F when applying sealant.

3.3.5 Exterior Sealant

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Color(s) will be selected by the Contracting Officer. Apply the sealant in accordance with the manufacturer's printed instructions. Force sealant into joints with sufficient pressure to fill the joints solidly. Apply sealant uniformly smooth and free of wrinkles.

3.3.6 Cleaning

Immediately remove fresh sealant from adjacent areas using a solvent recommended by the sealant manufacturer. Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean condition. Allow sealant time to cure, in accordance with manufacturer's recommendations, prior to coating.

3.4 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, [disintegrated coatings,] and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned

paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Refer to MPI ASM and MPI MRM for additional more specific substrate preparation requirements.

3.4.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

- a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.
- b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D235 or as specified in MPI MRM. Wipe the surfaces dry with a clean, dry, lint free cloth. Wipe immediately preceding the application of the first coat of any coating, unless specified otherwise.
- c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.
- d. The requirements specified are minimum. Comply also with the application instructions of the paint manufacturer and specific surface preparation requirements as outlined in MPI MRM Exterior Surface Preparation and Interior Surface Preparation.
- e. Thoroughly clean previously painted surfaces[specified to be repainted][damaged during construction] of all grease, dirt, dust or other foreign matter.
- f. Remove blistering, cracking, flaking and peeling or otherwise deteriorated coatings.
- g. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.
- h. Roughen slick surfaces. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.
- i. Feather and sand smooth edges of chipped paint.
- j. Clean rusty metal surfaces in accordance with SSPC requirements. Use solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting.
- k. Provide new, proposed coatings that are compatible with existing coatings.
- 3.4.2 Removal of Existing Coatings

Remove existing coatings from the following surfaces:

a. Surfaces containing large areas of minor defects;

- b. Surfaces containing more than 20 percent peeling area; and
- c. Surfaces designated by the Contracting Officer, such as surfaces where rust shows through existing coatings.
- 3.4.3 Substrate Repair
 - a. Repair substrate surface damaged during coating removal;
 - b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and
 - c. Clean and prime the substrate as specified.
- 3.5 PREPARATION OF METAL SURFACES
- 3.5.1 Existing and New Ferrous Surfaces
 - a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: [Solvent clean][or][detergent wash] in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to [SSPC SP 2,][SSPC SP 3,][SSPC SP 6/NACE No.3,] or [SSPC SP 10/NACE No. 2].[Brush-off blast remaining surface in accordance with SSPC 7/NACE No.4]; [Water jetting to SSPC-SP WJ-4/NACE WJ-4 may be used to remove loose coating and other loose materials. Use inhibitor as recommended by coating manufacturer to prevent premature rusting.] Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.
 - b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with [SSPC SP 6/NACE No.3 / SSPC-SP WJ-3/NACE WJ-3][SSPC SP 10/NACE No. 2 / SSPC-SP WJ-2/NACE WJ-2].

3.5.2 Final Ferrous Surface Condition:

3.5.2.1 Tool Cleaned Surfaces

Comply with SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.

3.5.3 Galvanized Surfaces

- a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with [solvent,][steam,][or][non-alkaline detergent solution]in accordance with SSPC SP 1. Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.
- b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC-SP WJ-3/NACE WJ-3 to remove loose

coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

c. Galvanized With Severe Deteriorated Coating or Severe Rusting: [Water jet to SSPC-SP WJ-3/NACE WJ-3 degree of cleanliness.][Spot abrasive blast rusted areas as described for steel in SSPC SP 6/NACE No.3, and waterjet to SSPC-SP WJ-3/NACE WJ-3 to remove existing coating.]

3.5.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.5.5 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

- 3.6 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE
- 3.6.1 Concrete and Masonry
 - Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.
 - b. Surface Cleaning: Remove the following deleterious substances.
 - (1) Dirt, Chalking, Grease, and Oil: Wash new and existing uncoated surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. Wash existing coated surfaces with a suitable detergent and rinse thoroughly. For large areas, water blasting may be used.
 - (2) Fungus and Mold: Wash new, existing coated, and existing uncoated] surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.
 - (3) Paint and Loose Particles: Remove by wire brushing.
 - (4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.
 - (5) Removal of Existing Coatings: For surfaces to receive textured coating MPI 42, remove existing coatings including soundly adhered coatings if recommended by textured coating manufacturer.
 - c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and

minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.

- d. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturer's recommendations. Allow surfaces to cure a minimum of 30 days before painting.
- 3.6.2 Gypsum Board, Plaster, and Stucco
- 3.6.2.1 Surface Cleaning

Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint is water-based.

3.6.2.2 Repair of Minor Defects

Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

3.6.2.3 Allowable Moisture Content

Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. Verify that new plaster to be coated has a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

3.7 PREPARATION OF WOOD AND PLYWOOD SURFACES

3.7.1 New, Existing Uncoated, and Existing Coated Plywood and Wood Surfaces, Except Floors:

- a. Surface Cleaning: Clean wood surfaces of foreign matter. Verify that surfaces are free from dust and other deleterious substances and in a condition approved by the Contracting Officer prior to receiving paint or other finish. Do not use water to clean uncoated wood. Scrape to remove loose coatings. Lightly sand to roughen the entire area of previously enamel-coated wood surfaces.
- Removal of Fungus and Mold: Wash existing coated surfaces with a solution composed of 3 ounces (2/3 cup) trisodium phosphate, one ounce (1/3 cup) household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.
- c. Do not exceed 12 percent moisture content of the wood as measured by a moisture meter in accordance with ASTM D4444, Method A, unless otherwise authorized.
- d. Prime or touch up wood surfaces adjacent to surfaces to receive

water-thinned paints before applying water-thinned paints.

- e. Cracks and Nailheads: Set and putty stop nailheads and putty cracks after the prime coat has dried.
- f. Cosmetic Repair of Minor Defects:
 - (1) Knots and Resinous Wood: Prior to application of coating, cover knots and stains with two or more coats of 3-pound-cut shellac varnish, plasticized with 5 ounces of castor oil per gallon. Scrape away existing coatings from knotty areas, and sand before treating. Prime before applying any putty over shellacked area.
 - (2) Open Joints and Other Openings: Fill with whiting putty, linseed oil putty. Sand smooth after putty has dried.
 - (3) Checking: Where checking of the wood is present, sand the surface, wipe and apply a coat of pigmented orange shellac. Allow to dry before paint is applied.
- g. Prime Coat For New Exterior Surfaces: Prime coat wood doors, windows, frames, and trim before wood becomes dirty or warped.
- 3.7.2 Wood Floor Surfaces, Natural Finish
 - a. Initial Surface Cleaning: As specified in Article SURFACE PREPARATION.
 - b. Existing Loose Boards and Shoe Molding: Before sanding, renail loose boards. Countersink nails and fill with an approved wood filler. Remove shoe molding before sanding and reinstall after completing other work. At Contractor's option, new shoe molding may be provided in lieu of reinstalling old. Provide new wood molding of the same size, wood species, and finish as the existing.
 - c. Sanding and Scraping: Sanding of wood floors is specified in Section [09 64 29 WOOD STRIP AND PLANK FLOORING] [09 64 23 WOOD PARQUET FLOORING] [09 64 66 WOOD ATHLETIC FLOORING] [09 64 00 PORTABLE (DEMOUNTABLE) WOOD FLOORING]. Fill floors of oak or similar open-grain wood with wood filler recommended by the finish manufacturer and the excess filler removed.
 - d. Final Cleaning: After sanding, sweep and vacuum floors clean. Do not walk on floors thereafter until specified sealer has been applied and is dry.

3.7.3 Interior Wood Surfaces, Stain Finish

Sand interior wood surfaces to receive stain. Fill oak and other open-grain wood to receive stain with a coat of wood filler not less than 8 hours before the application of stain; remove excess filler and sand the surface smooth.

3.8 APPLICATION

- 3.8.1 Coating Application
 - a. Comply with applicable federal, state and local laws enacted to ensure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all

substrates, except as modified herein.

- At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.
- c. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Use rollers for applying paints and enamels of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.
- d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.
- e. Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.
- f. Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.
- g. Touch up damaged coatings before applying subsequent coats.[Broom clean and clear dust from interior areas before and during the application of coating material.]
- i. Piping in Unfinished Areas: Provide primed surfaces with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 1.0 mil in attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and spaces where walls or ceiling are not painted or not constructed of a prefinished material.
- j. Piping in Finished Areas: Provide primed surfaces with two coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 1.0 mil or two component gloss polyurethane (MPI 72) in exterior applications.
- k. Provide labeling on the surfaces of all feed and cross mains to show the pipe function such as "Sprinkler System", "Fire Department Connection", "Standpipe". For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 in in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75 in in height and visible from the floor.
- 1. All fire suppression system valves must be marked with permanent tags indicating normally open or normally closed.
-] m. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.
 - n. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by

manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.

o. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

3.8.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than one pint of suitable thinner per gallon. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

3.8.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

- 3.8.4 Coating Systems
 - a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table for Exterior Applications				
MPI Division	Substrate Application			
MPI Division 3	Exterior Concrete Paint Table			
MPI Division 4	Exterior Concrete Masonry Units Paint Table			
MPI Division 5	Exterior Metal, Ferrous and Non-Ferrous Paint Table			
MPI Division 6	Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table			
MPI Division 9	Exterior Stucco Paint Table			
MPI Division 10	Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table			
Table for Interior Applications				
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MPI Division	Substrate Application			
MPI Division 3	Interior Concrete Paint Table			
MPI Division 4	Interior Concrete Masonry Units Paint Table			
MPI Division 5	Interior Metal, Ferrous and Non-Ferrous Paint Table			
MPI Division 6	Interior Wood Paint Table			
MPI Division 9	Interior Plaster, Gypsum Board, Textured Surfaces Paint Table			

- b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness, where specified, refers to the minimum dry film thickness.
- c. Coatings for Surfaces Not Specified Otherwise: Coat unspecified surfaces the same as surfaces having similar conditions of exposure.
- d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:
 - (1) One coat of primer.
 - (2) One coat of undercoat or intermediate coat.
 - (3) One topcoat to match adjacent surfaces.
- e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.
- 3.9 COATING SYSTEMS FOR METAL

Apply coatings of Tables in MPI Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer to steel surfaces on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.
- b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.
- c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.
- d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.
- e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat. Overcoat these items with the specified ferrous-metal primer prior to application of

finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.10 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 3, 4 and 9 for Exterior and Interior.

- 3.11 COATING SYSTEMS FOR WOOD AND PLYWOOD
 - a. Apply coatings of Tables in MPI Division 6 for Exterior and Interior.
 - b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.
 - c. Apply stains in accordance with manufacturer's printed instructions.
 - d. Wood Floors to Receive Natural Finish: Thin first coat 2 to 1 using thinner recommended by coating manufacturer. Apply all coatings at rate of 300 to 350 square feet per gallon. Apply second coat not less than 2 hours and not over 24 hours after first coat has been applied. Apply with lamb's wool applicators or roller as recommended by coating manufacturer. Buff or lightly sand between intermediate coats as recommended by coating manufacturer's printed instructions.

3.12 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with [MIL-STD-101] [ASME A13.1]. Place stenciling in clearly visible locations. On piping not covered by [MIL-STD-101] [ASME A13.1], stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.13 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.14 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers.

3.15 PAINT TABLES

All DFT's are minimum values.[Use only materials with a MPI GPS-1-14 green check mark having a minimum MPI "Environmentally Friendly" [E1] [E2] [E3] rating based on VOC (EPA Method 24) content levels.] Acceptable products are listed in the MPI Green Approved Products List, available at http://www.specifygreen.com/APL/ProductIdxByMPInum.asp.

3.15.1 Exterior Paint Tables

3.15.1.1 MPI Division 5: Exterior Metal, Ferrous and Non-Ferrous Paint Table

A. Steel / Ferrous Surfaces

(1) New Steel that has been hand or power tool cleaned to $\frac{\rm SSPC}{\rm SP}$ 2 or $\frac{\rm SSPC}{\rm SP}$ 3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1Q-G5 (Semigloss	MPI REX 5.1D-G5 (Semigloss)	MPI 23	MPI 94	MPI 94	5.25 mils
MPI EXT 5.1Q-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 23	MPI 9	MPI 9	5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(2) New Steel that has been blast-cleaned to SSPC SP 6/NACE No.3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1D-G5 (Semigloss)	MPI REX 5.1D-G5 (Semigloss)	MPI 79	MPI 94	MPI 94	5.25 mils
MPI EXT 5.1D-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 79	MPI 9	MPI 9	5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(3) Existing steel that has been spot-blasted to SSPC SP 6/NACE No.3

(a) Surface previously coated with alkyd or latex

Waterborne Light Industrial Coating

Existing, previously coated with alkyd or latex	Primer	Intermediate	Topcoat	System DFT	
MPI REX 5.1C-G5 (Semigloss)	MPI 79	MPI 163	MPI 163	5 mils	
MPI REX 5.1C-G6 (Gloss)	MPI 79	MPI 164	MPI 164	5 mils	
Topcoat: Coating to match adjacent surfaces.					

(b) Surfaces previously coated with epoxy

Existing, previously coated with epoxyPrimerIntermediateMPI REX 5.1L-G5 (Semigloss)MPI 101MPI 163MPI	Topcoat	System DFT
MPI REX 5.1L-G5 MPI 101 MPI 163 MP	DT 100	
	1PI 163 -	5 mils
MPI REX 5.1L-G6 MPI 101 MPI 164 MP	1PI 164 .	5 mils

Pigmented Polyurethane					
Existing, previously coated with epoxy	Primer	Intermediate	Topcoat	System DFT	
MPI REX 5.1H-G6 (Gloss)	MPI 101	MPI 108	MPI 72	8.5 mils	
Topcoat: Coating to match adjacent surfaces.					

(4) New and existing steel blast cleaned to SSPC SP 10/NACE No. 2

Waterborne Light Industrial					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1R-G5 (Semigloss)	MPI EXT 5.1R-G5 (Semigloss)	MPI 101	MPI 108	MPI 163	8.5 mils

MPI EXT 5.1R-G6 (Gloss)	MPI EXT 5.1R-G6 (Gloss)	MPI 101	MPI 108	MPI 164	8.5 mils	
Topcoat: Coating to match adjacent surfaces.						

Pigmented Polyurethane					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1J-G6 (Gloss)	MPI EXT 5.1J-G6 (Gloss)	MPI 101	MPI 108	MPI 72	8.5 mils
Topcoat: Coating to match adjacent surfaces.					

B. Exterior Galvanized Surfaces

(1) New Galvanized surfaces

Waterborne Primer / Latex					
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 5.3H-G1 (Flat)	MPI 134	MPI 10	MPI 10	4.5 mils	
EXT 5.3H-G5 (Semigloss)	MPI 134	MPI 11	MPI 11	4.5 mils	
MPI EXT 5.3H-G6 (Gloss)	MPI 134	MPI 119	MPI 119	4.5 mils	
Topcoat: Coating to match adjacent surfaces.					

Waterborne Primer / Waterborne Light Industrial Coating					
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 5.3J-G5 (Semigloss)	MPI 134	MPI 163	MPI 163	4.5 mils	
MPI EXT 5.3J-G6 (Gloss)	MPI 134	MPI 164	MPI 164	4.5 mils	
Topcoat: Coating to match adjacent surfaces.					

Epoxy Primer / Waterborne Light Industrial Coating					
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 5.3K-G5 (Semigloss)	MPI 101	MPI 163	MPI 163	5 mils	
MPI EXT 5.3K-G6 (Gloss)	MPI 101	MPI 164	MPI 164	5 mils	
Topcoat: Coating to match adjacent surfaces.					

Pigmented Polyurethane				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3L-G6 (Gloss)	MPI 101	N/A	MPI 72	5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Galvanized surfaces with slight coating deterioration; little or no rusting

Waterborne Light Industrial Coating				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3J-G5 (Semigloss)	MPI 134	N/A	MPI 163	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3D-G6 (Gloss)	MPI 101	N/A	MPI 72	5 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Galvanized surfaces with severely deteriorated coating or rusting

Waterborne Light Industrial Coating				
Galvanized surfaces with severely deteriorated coating or rusting	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3L-G5(Semigloss)	MPI 101	MPI 108	MPI 163	8.5 mils
MPI REX 5.3L-G6(Gloss)	MPI 101	MPI 108	MPI 164	8.5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Galvanized surfaces with severely deteriorated coating or rusting	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3D-G6(Gloss)	MPI 101	MPI 72	MPI 72	5 mils
Topcoat: Coating to match adjacent surfaces.				

C. Exterior Surfaces, Other Metals (Non-Ferrous)

(1) Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment

Alkyd				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 8	MPI 8	5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 94	MPI 94	5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 9	MPI 9	5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 161	MPI 161	5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 163	MPI 163	5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 164	MPI 164	5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Existing roof surfaces previously coated

Aluminum Pigmented Asphalt Roof Coating				
Existing roof surfaces previously coated	N/A	Intermediate	Topcoat	System DFT
Non-MPI System	ASTM D2824/D28	N/A	N/A	8 mils
Sufficient coats to provide not less than 8 mils of finished coating system (without asbestos fibers).				

Aluminum Paint				
Existing roof surfaces previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 10.2D	MPI 107	MPI 1	MPI 1	3.5 mils
Topcoat: Coating to match adjacent surfaces.				

(3) Surfaces adjacent to painted surfaces; [Mechanical,] [Electrical,] [Fire extinguishing sprinkler systems including valves, conduit, hangers, supports,][exposed copper piping,] [and miscellaneous metal items] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

Alkyd

New	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 5.1D-G1 (Flat)	MPI 79	MPI 8	MPI 8	5.25 mils	
MPI EXT 5.1D-G5 (Semigloss)	MPI 79	MPI 94	MPI 94	5.25 mils	
MPI EXT 5.1D-G6 (Gloss)	MPI 79	MPI 9	MPI 9	5.25 mils	
Topcoat: Coating to match adjacent surfaces.					

Waterborne Light Industrial Coating					
New	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 5.1C-G3(Eggshell)	MPI 79	MPI 161	MPI 161	5 mils	
MPI EXT 5.1C-G5(Semigloss)	MPI 79	MPI 163	MPI 163	5 mils	
MPI EXT 5.1C-G6(Gloss)	MPI 79	MPI 164	MPI 164	5 mils	
Primer as recommended by manufacturer. Topcoat: Coating to match adjacent surfaces.					

D. Exterior Hot Surfaces

(1) Hot metal surfaces [including smokestacks] subject to temperatures up to 400 degrees $\ensuremath{\mathsf{F}}$

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(2) Ferrous metal subject to high temperature, up to 750 degrees $\ensuremath{\mathsf{F}}$

Inorganic Zinc Rich Coating						
New	N/A	Intermediate	Topcoat	System DFT		
MPI EXT 5.2C	MPI 19	N/A	N/A	Per Manufacturer		

Surface preparation and number of coats per manufacturer's instructions.

Heat Resistant Aluminum Enamel						
New	N/A	Intermediate	Topcoat	System DFT		
MPI EXT 5.2B	MPI 2	N/A	N/A	Per Manufacturer		
Surface preparation and number of coats per manufacturer's instructions.						

(3) [New surfaces][and][Existing surfaces] made bare subject to temperatures up to 1100 degrees ${\rm F}$

(1) [New surfaces][and][Existing surfaces] made bare cleaning to SSPC SP 10/NACE No. 2 subject to temperatures up to 1100 degrees F

Heat Resistant Coating						
New	Existing	N/A	Intermediate	Topcoat	System DFT	
MPI EXT 5.2D	MPI REX 5.2D	MPI 22	N/A	N/A	Per Manufacturer	
Surface preparation and number of coats per manufacturer's instructions.						

3.15.1.2 MPI Division 6: Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table

A. New [and Existing, uncoated] Dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] not otherwise specified

Alkyd						
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT	
MPI EXT 6.3B-G5 (Semigloss)	MPI EXT 6.3B-G5 (Semigloss)	MPI 5	MPI 94	MPI 94	5 mils	
MPI EXT 6.3B-G6 (Gloss)	MPI EXT 6.3B-G6 (Gloss)	MPI 5	MPI 9	MPI 9	5 mils	
Topcoat: Coating to match adjacent surfaces.						

Latex					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3A-G1 (Flat)	MPI EXT 6.3A-G1 (Flat)	MPI 5	MPI 10	MPI 10	5 mils

MPI EXT	MPI EXT 6.3B-G5	MPI 5	MPI 11	MPI 11	5 mils
(Semigloss)	(Semigross)				
MPT EXT	MPT EXT 6 3B-G6	MPT 5	MPT 119	MPT 119	5 mils
6.3A-G6 (Gloss)	(Gloss)				0 11110
Topcoat: Coating to match adjacent surfaces.					

Waterborne Solid Color Stain					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 6.3K	MPI EXT 6.3K	MPI 5	MPI 16	MPI 16	4.25 mils
Topcoat: Coating to match adjacent surfaces.					

B. Existing, dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] previously coated with an alkyd / oil based finish coat not otherwise specified

Alkyd					
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT	
MPI REX 6.3B-G5 (Semigloss)	MPI 5	MPI 94	MPI 94	5 mils	
MPI REX 6.3B-G6 (Gloss)	MPI 5	MPI 9	MPI 9	5 mils	

		Latex		
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT
MPI REX 6.3A-G1 (Flat)	MPI 5	MPI 10	MPI 10	5 mils
MPI REX 6.3B-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	5 mils
MPI REX 6.3B-G6 (Gloss)	MPI 5	MPI 119	MPI 119	5 mils

C. Existing, dressed lumber, Wood and plywood, trim, [including top, bottom and edges of doors] previously coated with a latex / waterborne finish coat not otherwise specified

Latex						
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT		
MPI REX 6.3L-G1 (Flat)	MPI 6	MPI 10	MPI 10	4.5 mils		

MPI REX 6.3L-G5 (Semigloss)	MPI 6	MPI 11	MPI 11	4.5 mils
MPI REX 6.3L-G6 (Gloss)	MPI 6	MPI 119	MPI 119	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Solid Color Stain						
Existing, previously coated	Primer	Intermediate	Topcoat	System DFT		
MPI EXT 6.3K	MPI 6	MPI 16	MPI 16	4 mils		
Topcoat: Coating to match adjacent surfaces.						

D. Wood Siding

(1) New, Uncoated wood siding

Semi-Transparent Stain						
New	Topcoat	System DFT				
MPI EXT 6.3D	N/A	MPI 13	MPI 13	N/A		
Topcoat: Coating to match adjacent surfaces.						

(2) Existing, previously stained wood siding

Latex						
Existing, previously stained	Primer	Intermediate	Topcoat	System DFT		
MPI REX 6.2K-G1 (Flat)	MPI 5	MPI 10	MPI 10	4.5 mils		
MPI REX 6.2K-G5 (Semigloss)	MPI 5	MPI 11	MPI 11	4.5 mils		
Topcoat: Coating to match adjacent surfaces.						

(3) Existing Uncoated or previously semitransparent stained wood siding

Semi-Transparent Stain						
Existing	Primer	Intermediate	Topcoat	System DFT		

MPI REX 6.3D	N/A	MPI 13	MPI 13	Per Manufacturer
Topcoat: Co	ating to match ad	jacent surfaces.		

E. Wood: [Steps,] [platforms,] [floors of open porches,] and [____] [with non-skid additive (NSA), load at manufacturer's recommendations.]

Latex Floor Paint						
New	Primer	Intermediate	Topcoat	System DFT		
MPI EXT 6.5A-G2 (Flat)	MPI 5	MPI 60 [plus NSA]	MPI 60 [plus NSA]	4.5 mils		
MPI EXT 6.5A-G6 (Gloss)	MPI 5	MPI 68 [plus NSA]	MPI 68 [plus NSA]	4.5 mils		
Topcoat: Coating to match adjacent surfaces. Load non-skid additive (NSA) at manufacturer's recommendations.						

Alkyd Floor Paint						
New	Primer	Intermediate	Topcoat	System DFT		
MPI EXT 6.5B-G2 (Flat)	MPI 59	MPI 59 [plus NSA]	MPI 59 [plus NSA]	5 mils		
MPI EXT 6.5B-G6 (Gloss)	MPI 27	MPI 27 [plus NSA]	MPI 27 [plus NSA]	5 mils		
Topcoat: Coating to match adjacent surfaces. Load non-skid additive (NSA) at manufacturer's recommendations.						

3.15.2 Interior Paint Tables

3.15.2.1 MPI Division 3: Interior Concrete Paint Table

A. [New and uncoated existing] [and Existing, previously painted] Concrete, vertical surfaces, not specified otherwise

		Latex			
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1A-G2 (Flat)	MPI RIN 3.1A-G2 (Flat)	MPI 3	MPI 44	MPI 44	4 mils
MPI INT 3.1A-G3 (Eggshell)	MPI RIN 3.1A-G3 (Eggshell)	MPI 3	MPI 52	MPI 52	4 mils
MPI INT 3.1A-G5	MPI RIN 3.1A-G5 (Semigloss)	MPI 3	MPI 54	MPI 54	4 mils

Topcoat: Coating to match adjacent surfaces.

Nich Derformance Architectural Later					
	nigh reitoima	ance Archiri	Lectural Late	~	
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1C-G2 (Flat)	MPI RIN 3.1J-G2 (Flat)	MPI 3	MPI 138	MPI 138	4 mils
MPI INT 3.1C-G3 (Eggshell)	MPI RIN 3.1J-G3 (Eggshell)	MPI 3	MPI 139	MPI 139	4 mils
MPI INT 3.1C-G4 (satin)	MPI RIN 3.1J-G4	MPI 3	MPI 140	MPI 140	4 mils
MPI INT 3.1C-G5 (Semigloss)	MPI RIN 3.1J-G5 (Semigloss)	MPI 3	MPI 141	MPI 141	4 mils
Topcoat: Coating to match adjacent surfaces.					

Institutional Low Odor / Low VOC Latex						
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT	
MPI INT 3.1M-G2 (Flat)	MPI RIN 3.1L-G2 (Flat)	MPI 149	MPI 144	MPI 144	4 mils	
MPI INT 3.1M-G3 (Eggshell)	MPI RIN 3.1L-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	4 mils	
MPI INT 3.1M-G4 (satin)	MPI RIN 3.1L-G4	MPI 149	MPI 146	MPI 146	4 mils	
MPI INT 3.1M-G5 (Semigloss)	MPI RIN 3.1L-G5 (Semigloss)	MPI 149	MPI 147	MPI 147	4 mils	
Topcoat: Coating to match adjacent surfaces.						

B. Concrete Ceilings, Uncoated

Latex Aggregate					
New, uncoated	Primer	Intermediate	Topcoat	System DFT	
MPI INT 3.1N-G1 (Flat)	N/A	N/A	MPI 42	Per Manufacturer	

Texture - [Fine] [Medium] [Coarse]. Surface preparation, number of coats, and primer in accordance with manufacturer's instructions. Topcoat: Coating to match adjacent surfaces.

C. [New and uncoated existing] [and] [Existing, previously painted] Concrete in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [___] [and other high-humidity areas] not otherwise specified except floors

Waterborne Light Industrial Coating						
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT	
MPI INT 3.1L-G3(Eggshell	MPI RIN 3.1C-G3(Eggshell	MPI 3	MPI 151	MPI 151	4.8 mils	
MPI INT 3.1L-G5(Semiglos	MPI RIN 3.1C-G5(Semiglos	MPI 3	MPI 153	MPI 153	4.8 mils	
MPI INT 3.1L-G6(Gloss)	MPI RIN 3.1C-G6(Gloss)	MPI 3	MPI 154	MPI 154	4.8 mils	
Topcoat: Coating to match adjacent surfaces.						

		Alkyd			
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 3.1D-G3 (Eggshell)	MPI RIN 3.1D-G3 (Eggshell)	MPI 3	MPI 51	MPI 51	4.5 mils
MPI INT 3.1D-G5 (Semigloss)	MPI RIN 3.1D-G5 (Semigloss)	MPI 3	MPI 47	MPI 47	4.5 mils
MPI INT 3.1D-G6 (Gloss)	MPI RIN 3.1D-G6 (Gloss)	MPI 3	MPI 48	MPI 48	4.5 mils
Topcoat: Coatin	ig to match adjace	ent surface	es.	•	

Ероху								
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT			
MPI INT 3.1F-G6 (Gloss)	MPI RIN 3.1E-G6 (Gloss)	MPI 77	MPI 77	MPI 77	4 mils			
Note: Primer ma	y be reduced for	penetratio	n per manufa	cturer's				

D. [New and uncoated existing][and Existing, previously painted] concrete walls and bottom of swimming pools

	Chlorinated Rubber								
New and uncoated existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT				
Chlorinated Rubber	Per Manufacturer	Per Manufacture	Per Manufacturer	Per Manufacturer	Per Manufacturer				
Note: Primer may be reduced for penetration per manufacturer's instructions.									

Ероху							
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT		
MPI INT 3.1F	MPI RIN 3.1E	MPI 77	MPI 77	MPI 77	4 mils		
Note: Primer may be reduced for penetration per manufacturer's instructions.							

E. [New and uncoated existing][and Existing, previously painted] concrete floors in following areas [____]

Latex Floor Paint								
New, uncoated Existing, Primer Intermediate Topcoat System DI Existing previously painted								
MPI INT	MPI RIN 3.2A-G2	MPI 60	MPI 60	MPI 60	5 mils			

Alkyd Floor Paint								
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT			
MPI INT 3.2B-G2 (Flat)	MPI RIN 3.2B-G2 (Flat)	MPI 59	MPI 59	MPI 59	5 mils			
Note: Primer ma instructions.	y be reduced for	penetratio	on per manufa	cturer's				

Ероху							
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT		

MPI INT 3.2C-G6 (Gloss)	MPI RIN 3.2C-G6 (Gloss)	MPI 77	MPI 77	MPI 77	5 mils
Note: Primer ma instructions.	y be reduced for	penetratic	on per manufa	cturer's	

3.15.2.2 MPI Division 4: Interior Concrete Masonry Units Paint Table

A. New[and uncoated Existing] Concrete Masonry

High Performance Architectural Latex								
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT			
MPI INT 4.2D-G2 (Flat)	MPI 4	N/A	MPI 139	MPI 138	11 mils			
MPI INT 4.2D-G3 (Eggshell)	MPI 4	N/A	MPI 139	MPI 139	11 mils			
MPI INT 4.2D-G4 (Satin)	MPI 4	N/A	MPI 140	MPI 140	11 mils			
MPI INT 4.2D-G5 (Semigloss)	MPI 4	N/A	MPI 141	MPI 141	11 mils			
Fill all holes in masonry surface								

Institutional Low Odor / Low VOC Latex								
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT			
MPI INT 4.2E-G2 (Flat)	MPI 4	N/A	MPI 144	MPI 144	4 mils			
MPI INT 4.2E-G3 (Eggshell)	MPI 4	N/A	MPI 145	MPI 145	4 mils			
MPI INT 4.2E-G4 (Satin)	MPI 4	N/A	MPI 146	MPI 146	4 mils			
MPI INT 4.2E-G5 (Semigloss)	MPI 4	N/A	MPI 147	MPI 147	4 mils			
Fill all holes in masonry surface								

B. Existing, Previously Painted Concrete Masonry

High Performance Architectural Latex

Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2K-G2 (Flat)	N/A	MPI 138	MPI 138	MPI 138	4.5 mils
MPI RIN 4.2K-G3 (Eggshell)	N/A	MPI 139	MPI 139	MPI 139	4.5 mils
MPI RIN 4.2K-G4	N/A	MPI 140	MPI 140	MPI 140	4.5 mils
MPI RIN 4.2K-G5 (Semigloss)	N/A	MPI 141	MPI 141	MPI 141	4.5 mils

Institutional Low Odor / Low VOC Latex								
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT			
MPI RIN 4.2L-G2 (Flat)	N/A	MPI 144	MPI 144	MPI 144	4 mils			
MPI RIN 4.2L-G3 (Eggshell)	N/A	MPI 145	MPI 145	MPI 145	4 mils			
MPI RIN 4.2L-G4 (Satin)	N/A	MPI 146	MPI 146	MPI 146	4 mils			
MPI RIN 4.2L-G5 (Semigloss)	N/A	MPI 147	MPI 147	MPI 147	4 mils			

C. New[and uncoated Existing] Concrete masonry units in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [____,] [and other high humidity areas] unless otherwise specified

Waterborne Light Industrial Coating								
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT			
MPI INT 4.2K-G3(Eggshell)	MPI 4	N/A	MPI 151	MPI 151	11 mils			
MPI INT 4.2K-G5(Semigloss	MPI 4	N/A	MPI 153	MPI 153	11 mils			
MPI INT 4.2K-G6(Gloss)	MPI 4	N/A	MPI 154	MPI 154	11 mils			
Fill all holes in masonry surface								

Alkyd						
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT	
MPI INT 4.2K-G3(Eggshell)	MPI 4	MPI 50	MPI 51	MPI 51	12 mils	
MPI INT 4.2K-G5(Semigloss	MPI 4	MPI 50	MPI 47	MPI 47	12 mils	
MPI INT 4.2K-G6(Gloss)	MPI 4	MPI 50	MPI 48	MPI 48	12 mils	
Fill all holes in masonry surface						

Ероху						
New, uncoated Existing	Filler	Primer	Intermediate	Topcoat	System DFT	
MPI INT 4.2G-G6 (Gloss)	MPI 116	N/A	MPI 77	MPI 77	10 mils	
Fill all holes in masonry surface						

D. Existing, previously painted, concrete masonry units in [toilets,] [food-preparation,] [food-serving,] [restrooms,] [laundry areas,] [shower areas,] [areas requiring a high degree of sanitation,] [_____,] [and other high humidity areas] unless otherwise specified

Waterborne Light Industrial Coating						
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT	
MPI RIN 4.2G-G3(Eggshell)	N/A	MPI 151	MPI 151	MPI 151	4.5 mils	
MPI RIN 4.2G-G5(Semigloss)	N/A	MPI 153	MPI 153	MPI 153	4.5 mils	
MPI RIN 4.2G-G6(Gloss)	N/A	MPI 154	MPI 154	MPI 154	4.5 mils	

Alkyd					
Existing, previously painted	Filler	Primer	Intermediate	Topcoat	System DFT
MPI RIN 4.2C-G3 (Eggshell)	N/A	MPI 17	MPI 51	MPI 51	4.5 mils

MPI RIN 4.2C-G5 (Semigloss)	N/A	MPI 17	MPI 47	MPI 47	4.5 mils
MPI RIN 4.2C-G6 (Gloss)	N/A	MPI 17	MPI 48	MPI 48	4.5 mils

Ероху					
Existing, Filler Primer Intermediate Topcoat System					System DFT
MPI RIN 4.2D-G6	N/A	MPI 77	MPI 77	MPI 77	5 mils

3.15.2.3 MPI Division 5: Interior Metal, Ferrous and Non-Ferrous Paint Table

A. Interior Steel / Ferrous Surfaces

(1) Metal,[Mechanical,][Electrical,][Fire extinguishing sprinkler systems including valves, conduit, hangers, supports,][Surfaces adjacent to painted surfaces (Match surrounding finish),][exposed copper piping,][and miscellaneous metal items] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

High Performance Architectural Latex						
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 5.1R-G2 (Flat)	MPI 76	MPI 138	MPI 138	5 mils		
MPI INT 5.1R-G3 (Eggshell)	MPI 76	MPI 139	MPI 139	5 mils		
MPI INT 5.1R-G5 (Semigloss)	MPI 76	MPI 141	MPI 141	5 mils		
Topcoat: Coating to match adjacent surfaces.						

Alkyd							
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT			
MPI INT 5.1E-G2 (Flat)	MPI 76	MPI 49	MPI 49	5.25 mils			
MPI INT 5.1E-G3 (Eggshell)	MPI 76	MPI 51	MPI 51	5.25 mils			
MPI INT 5.1E-G5 (Semigloss)	MPI 76	MPI 47	MPI 47	5.25 mils			

MPI INT 5.1E-G6 (Gloss)	MPI 76	MPI 48	MPI 48	5.25 mils
Topcoat: Coating to	match adjacer	nt surfaces.		

(2) Metal floors (non-shop-primed surfaces or non-slip deck surfaces) with non-skid additive (NSA), load at manufacturer's recommendations

Alkyd (over q.d. Alkyd Primer)					
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT	
MPI INT 5.1E-G5 (Semi-Gloss)	MPI 76	MPI 47	MPI 47	5.25 mils	
Topcoat: Coating to match adjacent surfaces.					

		Ероху			
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT	
MPI INT 5.1L-G6 (Gloss)	MPI 101	MPI 101	MPI 101	5.25 mils	
Topcoat: Coating to match adjacent surfaces.					

(3) Metal in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][____,][and other high-humidity areas] not otherwise specified except floors, hot metal surfaces, and new prefinished equipment

Alkyd						
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 5.1E-G3 (Eggshell)	MPI 76	MPI 51	MPI 51	5.25 mils		
MPI INT 5.1E-G5 (Semigloss)	MPI 76	MPI 47	MPI 47	5.25 mils		
MPI INT 5.1E-G6 (Gloss)	MPI 76	MPI 48	MPI 48	5.25 mils		
Topcoat: Coating t	o match adjac	ent surfaces.	-			

Alkyd; For Hand Tool Cleaning

New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 5.1T-G3 (Eggshell)	MPI 23	MPI 51	MPI 51	5.25 mils		
MPI INT 5.1T-G5 (Semigloss)	MPI 23	MPI 47	MPI 47	5.25 mils		
MPI INT 5.1T-G6 (Gloss)	MPI 23	MPI 48	MPI 48	5.25 mils		
Topcoat: Coating to match adjacent surfaces.						

(4) Ferrous metal in concealed damp spaces or in exposed areas having unpainted adjacent surfaces as follows: [____]

Aluminum Paint				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 5.1M	MPI 76	MPI 1	MPI 1	4.25 mils
Topcoat: Coating to match adjacent surfaces.				

(5) Miscellaneous non-ferrous metal items not otherwise specified except floors, hot metal surfaces, and new prefinished equipment. Match surrounding finish

High Performance Architectural Latex					
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT	
MPI INT 5.4F-G2 (Flat)	MPI 95	MPI 138	MPI 138	5 mils	
MPI INT 5.4F-G3 (Eggshell)	MPI 95	MPI 139	MPI 139	5 mils	
MPI INT 5.4F-G4 (Satin)	MPI 95	MPI 140	MPI 140	5 mils	
MPI INT 5.4F-G5 (Semigloss)	MPI 95	MPI 141	MPI 141	5 mils	
Topcoat: Coating to match adjacent surfaces.					

Alkyd

New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT	
MPI INT 5.4J-G2 (Flat)	MPI 95	MPI 49	MPI 49	5 mils	
MPI INT 5.4J-G3 (Eggshell)	MPI 95	MPI 51	MPI 51	5 mils	
MPI INT 5.4J-G5 (Semigloss)	MPI 95	MPI 47	MPI 47	5 mils	
MPI INT 5.4J-G6 (Gloss)	MPI 95	MPI 48	MPI 48	5 mils	
Topcoat: Coating to match adjacent surfaces.					

B. Hot Surfaces

(1) Hot metal surfaces [including smokestacks] subject to temperatures up to 400 degrees \ensuremath{F}

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(2) Ferrous metal subject to high temperature, up to 750 degrees F

Inorganic Zinc Rich Coating				
New	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2C	MPI 19	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

Heat Resistant Aluminum Enamel				
New N/A Intermediate Topcoat System DFT				
MPI INT 5.2B (Aluminum Finish)	MPI 2	N/A	N/A	Per Manufacturer

Surface preparation and number of coats per manufacturer's instructions.

(3) New and Existing Surfaces made bare subject to temperatures up to 1100 degrees $\ensuremath{\mathsf{F}}$

(1) [New surfaces] [and] [Existing surfaces] made bare cleaning to SSPC SP 10/NACE No. 2 subject to temperatures up to 1100 degrees F:

	Heat 1	Resistant (Coating		
New	Existing	N/A	Intermediate	Topcoat	System DFT
MPI INT 5.2D	MPI RIN 5.2D	MPI 22	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.					

3.15.2.4 MPI Division 6: Interior Wood Paint Table

- A. Interior Wood and Plywood
- (1) New[and Existing, uncoated] Wood and plywood not otherwise specified

High Performance Architectural Latex				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 6.4S-G3 (Eggshell)	MPI 39	MPI 139	MPI 139	4.5 mils
MPI INT 6.4S-G4 (Satin)	MPI 39	MPI 140	MPI 140	4.5 mils
MPI INT 6.4S-G5 (Semigloss)	MPI 39	MPI 141	MPI 141	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd					
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT	
MPI INT 6.4B-G3 (Eggshell)	MPI 45	MPI 51	MPI 51	4.5 mils	
MPI INT 6.4B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	4.5 mils	
MPI INT 6.4B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	4.5 mils	

Topcoat: Coating to match adjacent surfaces.

Institutional Low Odor / Low VOC Latex						
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.3V-G2 (Flat)	MPI 39	MPI 144	MPI 144	4 mils		
MPI INT 6.3V-G3 (Eggshell)	MPI 39	MPI 145	MPI 145	4 mils		
MPI INT 6.3V-G4 (Satin)	MPI 39	MPI 146	MPI 146	4 mils		
MPI INT 6.3V-G5 (Semigloss)	MPI 39	MPI 147	MPI 147	4 mils		

(2) Existing, previously painted Wood and plywood not otherwise specified

High Performance Architectural Latex				
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 6.4B-G3 (Eggshell)	MPI 39	MPI 139	MPI 139	4.5 mils
MPI RIN 6.4B-G4 (Satin)	MPI 39	MPI 140	MPI 140	4.5 mils
MPI RIN 6.4B-G5 (Semigloss)	MPI 39	MPI 141	MPI 141	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Alkyd									
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT					
MPI RIN 6.4C-G3 (Eggshell)	MPI 46	MPI 51	MPI 51	4.5 mils					
MPI RIN 6.4C-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	4.5 mils					
MPI RIN 6.4C-G6 (Gloss)	MPI 46	MPI 48	MPI 48	4.5 mils					
Topcoat: Coating to match adjacent surfaces.									

Institutional Low Odor / Low VOC Latex									
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT					
MPI RIN 6.4D-G2 (Flat)	MPI 39	MPI 144	MPI 144	4 mils					
MPI RIN 6.4D-G3 (Eggshell)	MPI 39	MPI 145	MPI 145	4 mils					
MPI RIN 6.4D-G4 (Satin)	MPI 39	MPI 146	MPI 146	4 mils					
MPI RIN 6.4D-G5 (Semigloss)	MPI 39	MPI 147	MPI 147	4 mils					

B. Interior New [and Existing, previously finished or stained] Wood and Plywood, except floors; natural finish or stained

Natural finish, oil-modified polyurethane									
New	Existing	Primer	Intermediate	Topcoat	System DFT				
MPI INT 6.4J-G4	MPI RIN 6.4L-G4	MPI 57	MPI 57	MPI 57	4 mils				
MPI INT 6.4J-G6 (Gloss)	MPI RIN 6.4L-G6 (Gloss)	MPI 56	MPI 56	MPI 56	4 mils				

Stained, oil-modified polyurethane									
New	Existing	Stain	Primer	Intermediate	Topcoat	System DFT			
MPI INT 6.4E-G4MPI RIN 6.4G-G4MPI 90MPI 57MPI 57MPI 574 mils									
MPI INT 6.4E-G6 (Gloss)	MPI RIN 6.4G-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	4 mils			

Stained, Moisture Cured Urethane										
New	Existing	Stain	Primer	Intermediate	Topcoat	System DFT				
MPI INT 6.4V-G2 (Flat)	MPI RIN 6.4V-G2 (Flat)	MPI 90	MPI 71	MPI 71	MPI 71	4 mils				
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	4 mils				

C. Interior New[and Existing, previously finished or stained] Wood

Floors; Natural finish or stained

Natural finish, oil-modified polyurethane							
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.5C-G6 (Gloss)	MPI RIN 6.5C-G6 (Gloss)	MPI 56	MPI 56	MPI 56	4 mils		

Natural finish, Moisture Cured Polyurethane								
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT			
MPI INT 6.5K-G6 (Gloss)	MPI RIN 6.5D-G6 (Gloss)	MPI 31	MPI 31	MPI 31	4 mils			

Stained, oil-modified polyurethane								
New	Existing, previously finished or stained	Stain	Primer	ntermediate	Topcoat	System DFT		
MPI INT 6.5B-G6 (Gloss)	MPI RIN 6.5B-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	4 mils		

Stained, Moisture Cured Urethane								
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT		
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	4 mils		

D. New [and Existing, previously coated] Wood floors; pigmented finish

Latex Floor Paint									
New	Existing, previously finished	Primer	Intermediate	Topcoat	System DFT				

MPI INT 6.5G-G2 (Flat)	MPI RIN 6.5J-G2 (Flat)	MPI 45	MPI 60	MPI 60	4.5 mils			
MPI INT 6.5G-G6 (Gloss)	MPI RIN 6.5J-G6 (Gloss)	MPI 45	MPI 68	MPI 68	4.5 mils			
Topcoat: Coating to match adjacent surfaces.								

Alkyd Floor Paint									
New	Existing, previously finished	Primer	Intermediate	Topcoat	System DFT				
MPI INT 6.5A-G2 (Flat)	MPI RIN 6.5A-G2 (Flat)	MPI 59	MPI 59	MPI 59	4.5 mils				
MPI INT 6.5A-G6 (Gloss)	MPI RIN 6.5A-G6 (Gloss)	MPI 27	MPI 27	MPI 27	4.5 mils				
Topcoat: Coating to match adjacent surfaces.									

E. Interior New[and Existing, uncoated] wood surfaces in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][____][and other high humidity areas] not otherwise specified

High-Build	Glaze	Coatings
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As specified in Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Waterborne Light Industrial						
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.3P-G5 (Semigloss)	MPI 45	MPI 153	MPI 153	4.5 mils		
MPI INT 6.3P-G6 (Gloss)	MPI 45	MPI 154	MPI 154	4.5 mils		
Topcoat: Coating to match adjacent surfaces.						

Alkyd

New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.3B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	4.5 mils		
MPI INT 6.3B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	4.5 mils		
Topcoat: Coating to match adjacent surfaces.						

F. Existing, previously painted wood surfaces in[toilets,][
food-preparation,][food-serving,][restrooms,][laundry areas,][shower
areas,][areas requiring a high degree of sanitation,][____][and other
high humidity areas] not otherwise specified

High-Build Glaze Coatings

As specified in Section 09 96 59 HIGH-BUILD GLAZE COATINGS.

Waterborne Light Industrial							
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT			
MPI RIN 6.3P-G5 (Semigloss)	MPI 39	MPI 153	MPI 153	4.5 mils			
MPI RIN 6.3P-G6 (Gloss)	MPI 39	MPI 154	MPI 154	4.5 mils			
Topcoat: Coating to match adjacent surfaces.							

		Alkyd				
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT		
MPI RIN 6.3B-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	4.5 mils		
MPI RIN 6.3B-G6 (Gloss)	MPI 46	MPI 48	MPI 48	4.5 mils		
Topcoat: Coating to match adjacent surfaces.						

G. Interior New [and Existing, previously finished or stained] Wood Doors; Natural Finish or Stained

Natural finish, oil-modified polyurethane						
New	Existing, previously finished or stained	Primer	Intermediate	Topcoat	System DFT	

MPI INT	6.3K-G4	MPI RIN	6.3K-G4	MPI	57	MPI	57	MPI	57	4 mils
MPI INT 6.3K-G6	(Gloss)	MPI RIN 6.3K-G6	(Gloss)	MPI	56	MPI	56	MPI	56	4 mils
Note: Sand between all coats per manufacturers recommendations.										

Stained, oil-modified polyurethane							
New	Existing, previously finished or stained	Stain	Primer	ntermediate	Topcoat	System DFT	
MPI INT 6.3E-G4	MPI RIN 6.3E-G4	MPI 90	MPI 57	MPI 57	MPI 57	4 mils	
MPI INT 6.5B-G6 (Gloss)	MPI RIN 6.5B-G6 (Gloss)	MPI 90	MPI 56	MPI 56	MPI 56	4 mils	
Note: Sand between all coats per manufacturers recommendations.							

Stained, Moisture Cured Urethane							
New	Existing, previously finished or stained	Stain	Primer	ntermediat	Topcoat	System DFT	
MPI INT 6.4V-G2 (Flat)	MPI RIN 6.4V-G2 (Flat)	MPI 90	MPI 71	MPI 71	MPI 71	4 mils	
MPI INT 6.4V-G6 (Gloss)	MPI RIN 6.4V-G6 (Gloss)	MPI 90	MPI 31	MPI 31	MPI 31	4 mils	
Note: Sand between all coats per manufacturers recommendations.							

H. New [and Existing, uncoated] Wood Doors; Pigmented finish

		Alkyd				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.3B-G5 (Semigloss)	MPI 45	MPI 47	MPI 47	4.5 mils		
MPI INT 6.3B-G6 (Gloss)	MPI 45	MPI 48	MPI 48	4.5 mils		
Note: Sand between all coats per manufacturers recommendations.						

Pigmented Polyurethane

New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT		
MPI INT 6.1E-G6 (Gloss)	MPI 72	MPI 72	MPI 72	4.5 mils		
Note: Sand between all coats per manufacturers recommendations.						

I. Existing, previously painted Wood Doors; Pigmented finish

Alkyd							
Existing, previously finished	Primer	Intermediate	Topcoat	System DFT			
MPI RIN 6.3B-G5 (Semigloss)	MPI 46	MPI 47	MPI 47	4.5 mils			
MPI RIN 6.3B-G6 (Gloss)	MPI 46	MPI 48	MPI 48	4.5 mils			
Note: Sand between all coats per manufacturers recommendations.							

3.15.2.5 MPI Division 9: Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

A. Interior New[and Existing, previously painted][Plaster][and][Wallboard] not otherwise specified

		Latex			
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2A-G2 (Flat)	RIN 9.2A-G2 (Flat)	MPI 50	MPI 44	MPI 44	4 mils
MPI INT 9.2A-G3 (Eggshell)	RIN 9.2A-G3 (Eggshell)	MPI 50	MPI 52	MPI 52	4 mils
MPI INT 9.2A-G5 (Semigloss)	RIN 9.2A-G5 (Semigloss)	MPI 50	MPI 54	MPI 54	4 mils
Topcoat: Coating to match adjacent surfaces.					

High Performance Architectural Latex - High Traffic Areas					
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2B-G2 (Flat)	MPI RIN 9.2B-G2 (Flat)	MPI 50	MPI 138	MPI 138	4 mils

MPI INT 9.2B-G3 (Eggshell)	MPI RIN 9.2B-G3 (Eggshell)	MPI 50	MPI 139	MPI 139	4 mils
MPI INT 9.2B-G5 (Semigloss)	MPI RIN 9.2B-G5 (Semigloss)	MPI 50	MPI 141	MPI 141	4 mils
Topcoat: Coatir	ng to match adjace	ent surface	ës.		

Institutional Low Odor / Low VOC Latex, New

Institutional Low Odor / Low VOC Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2M-G2 (Flat)	MPI 149	MPI 144	MPI 144	4 mils
MPI INT 9.2M-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	4 mils
MPI INT 9.2M-G4 (Satin)	MPI 149	MPI 146	MPI 146	4 mils
MPI INT 9.2M-G5 (Semigloss)	MPI 149	MPI 147	MPI 147	4 mils
Topcoat: Coating to match adjacent surfaces.				

Institutional Low Odor / Low VOC Latex, Existing, previously painted

I	nstitutional 1	Low Odor / Low V	OC Latex	
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 9.2M-G2 (Flat)	MPI 144	MPI 144	MPI 144	4 mils
MPI RIN 9.2M-G3 (Eggshell)	MPI 144	MPI 145	MPI 145	4 mils
MPI RIN 9.2M-G4 (Satin)	MPI 144	MPI 146	MPI 146	4 mils
MPI RIN 9.2M-G5 (Semigloss)	MPI 144	MPI 147	MPI 147	4 mils
Topcoat: Coating to match adjacent surfaces.				

B. Interior New[and Existing, previously painted][Plaster][and][Wallboard] in[toilets,][food-preparation,][food-serving,][restrooms,][laundry areas,][shower areas,][areas requiring a high degree of sanitation,][____][and other high humidity areas] not otherwise specified

	Waterborne Light Industrial Coating				
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2L-G5(Semigloss)	MPI RIN 9.2L-G5 (Semigloss)	MPI 50	MPI 153	MPI 153	4 mils
Topcoat: Coating to match adjacent surfaces.					

		Alkyd			
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2C-G5 (Semigloss)	MPI RIN 9.2C-G5 (Semigloss)	MPI 50	MPI 47	MPI 47	4 mils
Topcoat: Coating	to match adjace	ent surfa	ces.		

Epoxy, New, uncoated Existing

		Ероху		
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2E-G6 (Gloss)	MPI 50	MPI 77	MPI 77	4 mils
Topcoat: Coating to match adjacent surfaces.				

Epoxy, Existing, previously painted

		Ероху		
Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI RIN 9.2D-G6 (Gloss)	MPI 17	MPI 77	MPI 77	4 mils
Topcoat: Coating to match adjacent surfaces.				

-- End of Section --

SECTION 22 00 00

PLUMBING, GENERAL PURPOSE 11/15, CHG 4: 05/21

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME	B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME	B31.1	(2022) Power Piping
ASME	B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME	BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
	AMERICAN SOCIETY OF SAN	ITARY ENGINEERING (ASSE)
ASSE	1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE	1019	(2011; R 2016) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance
	AMERICAN WATER WORKS ASS	SOCIATION (AWWA)
AWWA	10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA	C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA	C700	(2020) Cold-Water Meters - Displacement

Type, Metal Alloy Main CaseAWWA C701(2019) Cold-Water Meters - Turbine Type

for Customer Service

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction

ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D2822/D2822M	(2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
INTERNATIONAL CODE COUN	CIL (ICC)
ICC IPC	(2024) International Plumbing Code
MANUFACTURERS STANDARDI INDUSTRY (MSS)	ZATION SOCIETY OF THE VALVE AND FITTINGS
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
NACE INTERNATIONAL (NAC	Ε)
NACE SP0169	(2013) Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NATIONAL ELECTRICAL MAN	UFACTURERS ASSOCIATION (NEMA)
NEMA MG 1	(2021) Motors and Generators

NEMA MG 11 (1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201 (2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508 (2023) Hose Clamp Specifications

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SM 9223

(2004) Enzyme Substrate Coliform Test

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; G[, [____]]

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system ; 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.

SD-03 Product Data

WaterSense Label for Lavatory Faucet; S

Welding

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

Vibration-Absorbing Features; G[, [____]]

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

Plumbing System

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Diagrams, instructions, and other sheets proposed for posting.
] 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.

SD-07 Certificates

Materials and Equipment

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.

SD-10 Operation and Maintenance Data

Plumbing System; G[, []]

Submit in accordance with Section 01 $78\ 23$ OPERATION AND MAINTENANCE DATA.

1.3 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. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.1 Alternative Qualifications

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 or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Welding

[Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by 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 05 05 23.16 STRUCTURAL WELDING. Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.

1.5.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM and Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

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.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

- PART 2 PRODUCTS
- 2.1 MATERIALS

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

2.1.1 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- b. Copper, Sheet and Strip for Building Construction: ASTM B370.
- c. Asphalt Roof Cement: ASTM D2822/D2822M.

- d. Hose Clamps: SAE J1508.
- k. Gauges Pressure and Vacuum Indicating Dial Type Elastic Element: ASME B40.100.
- 1. Thermometers: ASTM E1. Mercury shall not be used in thermometers.
- 2.2 VALVES

Valves shall be provided on supplies to equipment and fixtures.. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85

2.2.1 Wall Hydrants (Frostproof)

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.2.2 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

2.3 DOMESTIC WATER SERVICE METER

The requirements for metering and submetering are specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 2-1/2 inches and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

Meters must be connected to the base wide energy and utility monitoring and control system (if this system exists) using the installation's advanced metering protocols.

2.4 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of

packaged equipment as an integral part of the equipment. Provide [high efficiency type,]single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. [In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide polyphase, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1.] Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. 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. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.5 MISCELLANEOUS PIPING ITEMS

2.5.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.5.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where [supply] drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

2.5.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.5.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.5.3 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.5.4 Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

2.5.5 Labels

Provide labels for sensor operators at flush valves and faucets. Include the following information on each label:

- a. Identification of the sensor and its operation with written description.
- b. Range of the sensor.
- c. Battery replacement schedule.

PART 3 EXECUTION

- 3.1 GENERAL INSTALLATION REQUIREMENTS
- 3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.2 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 ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.2 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.

3.1.3 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. The cathodic protection system, protective coating system, and joint bonding for cathodically protected pipe shall be in accordance with [Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM][and][Section 26 42 17 IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM]. Coatings shall be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

3.1.4 Pipe Sleeves and Flashing

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

3.1.4.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

- a. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.
- b. 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.

- c. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.
- d. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.
- e. 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 C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. 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.
- f. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and [concrete] [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 07 84 00 FIRESTOPPING.

3.1.4.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 10 inches. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 8 inches from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 10 inches in

diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

3.1.4.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 1-1/2 inches to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 1-1/2 inches; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 8 inches from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 1-1/2 inches to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.4.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 6 inches in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.
- 3.1.4.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS and WATERPROOFING, a groove 1/4 to 1/2 inch wide by 1/4 to 3/8 inch deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.4.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.5 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 07 84 00 FIRESTOPPING.

3.1.6 Supports

3.1.6.1 General

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

3.1.6.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and [Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC] [as shown]. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in[Section 05 12 00 STRUCTURAL STEEL][Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS][Section 05 51 33 METAL LADDERS][Section 05 52 00 METAL RAILINGS][Section 05 51 00 METAL STAIRS].

3.1.6.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to $MSS\ SP-58$ 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-58 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - (1) Be used on insulated pipe less than 4 inches.

- (2) Be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or less.
- (3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:
 - On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
 - (2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - (3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- 1. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.
- n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.6.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead

applications shall be constructed of ferrous materials only.

3.1.7 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.

3.1.8 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames,

anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.2 FIXTURES AND FIXTURE TRIMMINGS

3.3 VIBRATION-ABSORBING FEATURES

Mechanical equipment 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. Isolation unit installation shall limit vibration to [____] percent of the lowest equipment rpm.

3.4 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer.

3.5 IDENTIFICATION SYSTEMS

3.5.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.5.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 3/8 inch in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 3 foot width, 30 inches height, and 1/2 inch thickness. The board shall be made of wood fiberboard and framed under glass or 1/16 inch transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

Color	System	Item	Location
[]	[]	[]	[]

3.6 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.6.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.6.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.6.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.7 TESTS, FLUSHING AND DISINFECTION

3.7.1 Plumbing System

3.7.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated.

3.7.3 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and 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.
- d. Operation of each valve, hydrant, and faucet.

3.7.4 Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable 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.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with [EPA SM 9223] [AWWA 10084]. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial 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.

3.8 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.

3.9 TABLES

⁻⁻ End of Section --

SECTION 23 03 00.00 20

BASIC MECHANICAL MATERIALS AND METHODS 08/10, CHG 3: 08/18

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019)	Stan	ldard	Practice	for	Operating
	Salt S	pray	(Fog)	Apparatı	ıs	

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2023) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023;	ERTA	4	2023;	ERTA	5	2023;	ERTA	6
	2023)	Natior	nal	L Elect	trical	1 (Code		

1.2 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 21, FIRE SUPPRESSION; 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

- 1.3 QUALITY ASSURANCE
- 1.3.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.2 Alternative Qualifications

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 or laboratory tests, can be shown.

1.3.3 Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.4 Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" must be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" must be interpreted to mean the "lessor." References to the "permit holder" must be interpreted to mean the "Contractor."

1.3.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.6 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

1.6.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters [(except starters/controllers which are indicated as part of a motor control center)], control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, [the motor control equipment forming a part of motor control centers,] and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.6.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

- 1.6.3 High Efficiency Motors
- 1.6.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.6.3.2 High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in

accordance with Table 12-6C of NEMA MG 1.

1.6.4 Three-Phase Motor Protection

Provide controllers for motors rated one 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay. 1.7 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.8 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

3.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

3.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

- a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.
- b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F must receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.
- c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F must receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

-- End of Section --

SECTION 23 30 00

HVAC AIR DISTRIBUTION 05/20, CHG 1: 02/22

PART 1 GENERAL

1.1 REFERENCES

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

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S12.51	(2012; R 2017) American National Standard
	Acoustics - Determination of Sound Power
	Levels and Sound Energy Levels of Noise
	Sources using Sound Pressure - Precision
	Methods for Reverberation Test Rooms

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4	(2001)	Ins	stallati	on I	'echniques	for	
	Perimet	ter	Heating	and	l Cooling;	11th	Edition

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

AMCA	201	(2002; R 2011) Fans and Systems
AMCA	210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA	220	(2005;R 2012) Test Methods for Air Curtain Units
AMCA	300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA	301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA	500-D	(2018) Laboratory Methods of Testing Dampers for Rating
	AIR-CONDITIONING, H	HEATING AND REFRIGERATION INSTITUTE (AHRI)
AHRI	AIR-CONDITIONING, H	HEATING AND REFRIGERATION INSTITUTE (AHRI) (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment
AHRI AHRI	AIR-CONDITIONING, H 260 I-P 350	HEATING AND REFRIGERATION INSTITUTE (AHRI) (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment (2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
AHRI AHRI AHRI	AIR-CONDITIONING, H 260 I-P 350 410	<pre>HEATING AND REFRIGERATION INSTITUTE (AHRI) (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment (2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment (2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils</pre>
AHRI AHRI AHRI AHRI	AIR-CONDITIONING, H 260 I-P 350 410	HEATING AND REFRIGERATION INSTITUTE (AHRI) (2012) Sound Rating of Ducted Air Moving and Conditioning Equipment (2015) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment (2001; Addendum 1 2002; Addendum 2 2005; Addendum 3 2011) Forced-Circulation Air-Cooling and Air-Heating Coils (2009) Central-Station Air-Handling Units

AHRI 440	(2008) Performance Rating of Room Fan-Coils
AHRI 880 I-P	(2011) Performance Rating of Air Terminals
AHRI 885	(2008; Addendum 2011) Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets
AHRI DCAACP	(Online) Directory of Certified Applied Air-Conditioning Products
AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units
AMERICAN BEARING MANUFA	CTURERS ASSOCIATION (ABMA)
ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings
AMERICAN SOCIETY OF HEA' ENGINEERS (ASHRAE)	FING, REFRIGERATING AND AIR-CONDITIONING
ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 52.2	(2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 68	(1997) Laboratory Method of Testing to Determine the Sound Power In a Duct
ASHRAE 70	(2023) Method of Testing the Performance of Air Outlets and Inlets
ASHRAE 84	(2020; Errata 2021) Method of Testing Air-to-Air Heat/Energy Exchangers
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
AMERICAN SOCIETY OF MEC	HANICAL ENGINEERS (ASME)
ASME A13.1	(2023) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B152/B152M	(2019) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B280	(2023) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2020) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth
CALIFORNIA DEPARTMENT C	OF PUBLIC HEALTH (CDPH)
CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers
GERMAN INSTITUTE FOR SI	ANDARDIZATION (DIN)
DIN EN 14037	(2016) Free Hanging Heating and Cooling Surfaces for Water with a Temperature Below 120 Degrees C - Part 1: Pre-Fabricated Ceiling Mounted Radiant Panels for Space Heating
DIN EN 14240	(2004) Ventilation for Buildings
INSTITUTE OF ENVIRONMEN	TAL SCIENCES AND TECHNOLOGY (IEST)
IEST RP-CC-001	(2016; Rev 6) HEPA and ULPA Filters
NATIONAL ELECTRICAL MAN	UFACTURERS ASSOCIATION (NEMA)
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency
	Medium AC Squirrel-Cage Polyphase Induction Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 4 2023; ERTA 5 2023; ERTA 6 2023) National Electrical Code	
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems	
NFPA 96	(2024) Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations	
NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films	
SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)		
SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition	
SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition	
SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition	
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition	
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition	
SOUTH COAST AIR QUALITY	MANAGEMENT DISTRICT (SCAQMD)	
SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications	
U.S. DEPARTMENT OF DEFENSE (DOD)		
MIL-STD-101	(2014; Rev C) Color Code for Pipelines and for Compressed Gas Cylinders	
U.S. DEPARTMENT OF ENERGY FEDERAL ENERGY MANAGEMENT PROGRAM (FEMP)		
PL-109-58	(1992; R 2005) Energy Efiicient Procument Requirements	
U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)		
40 CFR 82	Protection of Stratospheric Ozone	
UNDERWRITERS LABORATORIES (UL)		
UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel	
UL 94	(2023; Reprint May 2023) UL Standard for	

	Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 705	(2017; Reprint Aug 2022) UL Standard for Safety Power Ventilators
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015; Reprint Aug 2022) UL Standard for SafetyStandard for Air Filter Units
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment
UL 2021	(2015; Reprint Dec 2016) UL Standard for Safety Fixed and Location-Dedicated Electric Room Heaters
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Construction	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities

such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - []
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - []
VAV Box Number	VAV - []
Fan Coil Unit Number	FC - []
Terminal Box Number	TB - []
Unit Ventilator Number	UV – []

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

- a. Each point of entry and exit of pipe passing through walls.
- b. Each change in direction, i.e., elbows, tees.
- c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.
- d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels must be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes		
for Outside Diameters of	Lettering	
1/2 thru 1-3/8 inch	1/2 inch	
1-1/2 thru 2-3/8 inch	3/4 inch	
2-1/2 inch and larger	1-1/4 inch	

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with [ASME A13.1] [MIL-STD-101].

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Metallic Flexible Duct

Insulated Nonmetallic Flexible Duct Runouts

Duct Connectors

Duct Access Doors; G

Fire Dampers

Manual Balancing Dampers; G

Sound Attenuation Equipment Acoustical Duct Liner Diffusers Registers and Grilles Louvers Air Vents, Penthouses, and Goosenecks

Centrifugal Fans

In-Line Centrifugal Fans Axial Flow Fans Panel Type Power Wall Ventilators Centrifugal Type Power Wall Ventilators Centrifugal Type Power Roof Ventilators Propeller Type Power Roof Ventilators Air-Curtain Fans Ceiling Exhaust Fans PL-109-58 label for ceiling exhaust fan product; S Air Handling Units; G Room Fan-Coil Units; G Coil Induction Units; G Constant Volume, Single Duct Terminal Units; G Variable Volume, Single Duct Terminal Units; G Variable Volume, Single Duct, Fan-Powered Terminal Units; G Dual Duct Terminal Units; G Ceiling Induction Terminal Units; G Reheat Units; G Unit Ventilators Energy Recovery Devices; G Hydronic Modular Panels; G Prefabricated Radiant-Heating Electric Panels; G Test Procedures Diagrams; G Indoor Air Quality for Duct Sealants; S SD-06 Test Reports Performance Tests; G Damper Acceptance Test; G SD-07 Certificates

Bolts

Ozone Depleting Substances Technician Certification SD-08 Manufacturer's Instructions Manufacturer's Installation Instructions Operation and Maintenance Training SD-10 Operation and Maintenance Data Operation and Maintenance Manuals; G Fire Dampers; G Manual Balancing Dampers; G

Centrifugal Fans; G In-Line Centrifugal Fans; G Axial Flow Fans; G Panel Type Power Wall Ventilators; G Centrifugal Type Power Wall Ventilators; G Centrifugal Type Power Roof Ventilators; G Propeller Type Power Roof Ventilators; G Air-Curtain Fans; G Ceiling Exhaust Fans; G Air Handling Units; G Room Fan-Coil Units; G Coil Induction Units; G Constant Volume, Single Duct Terminal Units; G Variable Volume, Single Duct Terminal Units; G Variable Volume, Single Duct, Fan-Powered Terminal Units; G Dual Duct Terminal Units; G Ceiling Induction Terminal Units; G Reheat Units; G Unit Ventilators; G

Energy Recovery Devices; G

Hydronic Modular Panels; G

Prefabricated Radiant-Heating Electric Panels; G

SD-11 Closeout Submittals

Indoor Air Quality During Construction; S

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

- a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.
- b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.
- c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.
- d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at <u>http://femp.energy.gov/procurement</u>.[Equipment having a lower efficiency may be specified if the designer determines such equipment to be more life-cycle cost effective.]

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.[Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.]

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are 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. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.3 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for catwalks, operating platforms, ladders, and guardrails are specified in Section 08 31 00 ACCESS DOORS AND PANELS.

2.4 ELECTRICAL WORK

- a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.
- b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.
- c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.
- d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply

fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.5 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.7 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing. Paint in accordance with Section 09 96 00 HIGH-PEFORMANCE COATINGS.

2.8 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.9 DUCT SYSTEMS

2.9.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

- b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.
- c. Provide ductwork that meets the requirements of Seal Class [A][C]. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.
- e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements
of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table). Provide validation of indoor air quality for duct sealants.

- f. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.
- g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.9.1.1 Metallic Flexible Duct

- a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches water gauge positive and 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 5 feet. Secure connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.
- b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.
- c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.9.1.3 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.9.1.4 High Temperature Service Duct Connections

Provide material that is approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

2.9.1.5 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.1.6 Copper Sheets

ASTM B152/B152M, light cold rolled temper.

2.9.1.7 Corrosion Resisting (Stainless) Steel Sheets

ASTM A167

2.9.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.9.3 Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce

the ceiling of the assemblies in conformance with UL Fire Resistance. Provide [curtain type with damper blades] [in the air stream] [out of the air stream][or][single blade type][or][multi-blade type] fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph DAMPER ACCEPTANCE TEST and NFPA 90A.

2.9.4 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.9.5 Air Supply And Exhaust Air Dampers

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

- a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.
- All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.9.6 Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide

factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

2.9.7 Plenums and Casings for Field-Fabricated Units

2.9.7.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.9.7.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.9.7.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 36 by 18 inches and locate them 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.9.7.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.9.7.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.9.8 Sound Attenuation Equipment

2.9.8.1 Systems with total pressure above 4 Inches Water Gauge

Provide sound attenuators on the discharge duct of each fan operating at a total pressure above 4 inch water gauge, and, when indicated, at the intake of each fan system. Provide sound attenuators elsewhere as indicated. Provide factory fabricated sound attenuators, tested by an independent laboratory for sound and performance characteristics. Provide a net sound reduction as indicated. Maximum permissible pressure drop is not to exceed 0.63 inch water gauge. Construct traps to be airtight when operating under an internal static pressure of 10 inch water gauge. Provide air-side surface capable of withstanding air velocity of 10,000 fpm. Certify that the equipment can obtain the sound reduction values specified after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Provide sound absorbing material conforming to ASTM C1071, Type I or II. Provide sound absorbing material that meets the fire hazard rating requirements for insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. For connection to ductwork, provide a duct transition section. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system can be provided if complying with requirements specified for factory fabricated sound attenuators, in lieu of factory fabricated sound attenuators. Construct the double-walled duct and fittings from an outer metal pressure shell of zinc-coated steel sheet, 1 inch thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Provide a sufficient length of run to obtain the noise reduction coefficient specified. Certify that the sound reduction value specified can be obtained within the length of duct run provided. Provide welded or spiral lock seams on the outer sheet metal of the double-walled duct to prevent water vapor penetration. Provide duct and fittings with an outer sheet that conforms to the metal thickness of high-pressure spiral and round ducts and fittings shown in SMACNA 1966. Provide acoustical insulation with a thermal conductivity "k" of not more than 0.27 Btu/inch/square foot/hour/degree F at 75 degrees F mean temperature. Provide an internal perforated zinc-coated metal liner that is not less than 24 gauge with perforations not larger than 1/4 inch in diameter providing a net open area not less than 10 percent of the surface.

2.9.8.2 System with total pressure of 4 Inch Water Gauge and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 24 by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

2.9.8.3 Acoustical Duct Liner

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 1 inch thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase duct sizes shown to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, provide acoustically equivalent lengths of fibrous glass duct, elastomeric duct liner or factory fabricated double-walled internally insulated duct with perforated liner.

2.9.9 Diffusers, Registers, and Grilles

Provide factory-fabricated units of [steel][corrosion-resistant steel][or][aluminum] that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.9.9.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.9.9.2 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise

indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.9.10 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel [or aluminum] sheets with galvanized[or aluminum] structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.9.11 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.9.12 Radon Exhaust Ductwork

Fabricate radon exhaust ductwork installed in or beneath slabs from Schedule 40 PVC pipe that conforms to ASTM D1785. Provide fittings that conform to ASTM D2466. Use solvent cement conforming to ASTM D2564 to make joints. Otherwise provide metal radon exhaust ductwork as specified herein.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than [150] [140] [120] percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading

ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

2.10.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. [Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 30 inches in diameter]. [Provide open-wheel radial type booster fans for exhaust dryer systems, and fans suitable for conveying lint and the temperatures encountered. Equip the fan shaft with a heat slinger to dissipate heat buildup along the shaft. Install an access (service) door to facilitate maintenance to these fans.] Provide fan wheels over 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Provide[[manually] [automatically] operated inlet vanes on suction inlets. Provide [manually] [automatically] operated outlet dampers.] Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosures. [Provide [manual] [magnetic] [across-the-line] [reduced-voltage-start] type motor starters with [general-purpose] [weather-resistant] [watertight] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.[Provide motors with [open][dripproof][totally enclosed] [explosion-proof] enclosure.] [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosures.][Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.3 Axial Flow Fans

Provide axial flow fans complete with drive components and belt guard, with steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Provide fan wheels that are dynamically balanced and keyed to the fan shaft, with radially projecting blades of airfoil cross-section. Enclose and isolate fan bearings and drive shafts from the air stream. Permanently lubricate fan bearings or provide them with accessible grease fittings. Provide precision self-aligning ball or roller type fan bearings that are sealed against dust and dirt. Provide fan bearings that have a L50 rated bearing life at not less than 200,000 hours of operation as defined by ABMA 9 and ABMA 11. Provide fan inlets with an aerodynamically shaped bell and an inlet cone. Install diffuser or straightening vanes at the fan discharge to minimize turbulence and provide smooth discharge air flow. Furnish fan unit with [inlet and outlet flanges,] [inlet screen,] [duct equalizer section,] and [manual] [automatic] operation adjustable inlet vanes. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have [open] [dripproof] [totally enclosed] [explosion-proof] enclosure. [Provide [manual] [magnetic] motor starters across-the-line with [general-purpose] [weather-resistant] [explosion-proof] enclosure.] [Provide remote manual switch with pilot indicating light where indicated.]

2.10.1.4 Panel Type Power Wall Ventilators

Provide propeller type fans, assembled on a reinforced metal panel with venturi opening spun into panel. Provide direct or V-belt driven fans with wheels less than 24 inches in diameter and provide V-belt driven fans with wheels 24 inches in diameter and larger. Provide fans with wall mounting collar. Provide lubricated bearings. Equip fans with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Provide [dripproof][totally enclosed fan cooled][explosion-proof] type motor enclosure. Install [gravity][motor operated] backdraft dampers where indicated.

2.10.1.5 Centrifugal Type Power Wall Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide removable and weatherproof motor housing. Provide unit housing that is designed for sealing to building surface and for discharge and condensate drippage away from building surface. Construct housing of heavy gauge aluminum. Equip unit with an [aluminum or plated steel wire discharge bird screen,] [disconnect switch,] [[anodized aluminum][stainless steel] wall grille,] [manufacturer's standard [gravity][motor-operated] damper,] an airtight and liquid-tight metallic wall sleeve. Provide [totally enclosed fan cooled] [dripproof] [explosion-proof] type motor enclosure. Use only lubricated bearings.

2.10.1.6 Centrifugal Type Power Roof Ventilators

Provide [direct][or][V-belt] driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with [birdscreen,] [disconnect switch,] [[gravity] [motorized] dampers,] [sound curb,] [roof curb,] and [extended base]. Provide [dripproof] [explosion-proof] type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705 and NFPA 96, fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings. If there is a conflict between NFPA 96 and UL 705 the most stringent wording must be adhered to.

2.10.1.7 Propeller Type Power Roof Ventilators

Provide [direct][or][V-belt] driven fans. Provide hinged or removable weathertight fan housing, fitted with framed rectangular base constructed of aluminum or galvanized steel. Provide [totally enclosed fan cooled] [explosion-proof] type motors. Furnish motors with nonfusible, horsepower rated, manual disconnect mount on unit. Furnish fans with [gravity] [motor operated] dampers, [birdscreen][sound curb][roof curb]. Use only lubricated bearings.

2.10.1.8 Air-Curtain Fans

Provide fans that conform to AMCA 220 with AMCA seal. Furnish air curtains with a weatherproof housing constructed of high impact plastic or minimum 18 gauge rigid welded steel. Provide backward curved, non-overloading, centrifugal type fan wheels, accurately balanced statically and dynamically. Provide motors with totally enclosed fan cooled enclosures. Provide remote manual type motor starters with weather-resistant enclosure actuated when the doorway served is open. Provide air curtains that attain the air velocities specified within 2 seconds following activation. Provide bird screens at air intake and discharge openings. Provide air curtain unit or a multiple unit installation that is at least as wide as the opening to be protected. Provide the air discharge openings to permit outward adjustment of the discharge air. Place installation and adjust according to the manufacturer's written recommendation. Furnish directional controls on air curtains for service windows for easy clean or convenient removal. Design air curtains to prevent the adjustment of the air velocities specified. Make the interior surfaces of the air curtain units accessible for cleaning. Provide certified test data indicating that the fan can provide the air velocities required when fan is mounted as indicated. Provide air curtains designed as fly fans unless otherwise indicated. [Provide air curtains designed for use in service entranceways that develop an air curtain not less than 3 inches thick at the discharge nozzle. Provide air velocity that is not less than 1600 fpm across the entire entryway when measured 3 feet above the floor.] [Provide air curtains designed for use on customer entranceways that develop an air curtain not less than 8 inches thick at the discharge opening. Provide velocity that is not less than 600 fpm across the entire entryway when measured 3 feet above the floor. Equip recirculating type air curtains with readily removable filters, or design the filters for in-position cleaning. Provide readily accessible and easily cleanable air capture compartment or design for in-position cleaning.] [Provide air curtains designed for use on service windows that develop an air curtain not less than 8 inches thick at the discharge opening. Provide air velocity that is not less than 600 fpm across the entire opening of the service window measured 3 feet below the air discharge opening.]

2.10.2 Coils

Provide fin-and-tube type coils constructed of seamless [copper][red brass] tubes and [aluminum][or][copper] fins mechanically bonded or soldered to the tubes.[Provide copper tube wall thickness that is a minimum of [0.016][0.020][0.024] inches].[Provide red brass tube wall thickness that is a minimum of [0.035] [0.049] inches]. [Provide aluminum fins that are

[0.0055][0.0075] inch minimum thickness.][Provide copper fins that are 0.0045 inch minimum thickness.] Provide casing and tube support sheets that are not lighter than 16 gauge galvanized steel, formed to provide structural strength. When required, provide multiple tube supports to prevent tube sag. Mount coils for counterflow service. Rate and certify coils to meet the requirements of AHRI 410.[Provide factory applied phenolic, vinyl or epoxy/electrodeposition coating.]

2.10.2.1 Direct-Expansion Coils

Provide suitable direct-expansion coils for the refrigerant involved. Provide refrigerant piping that conforms to ASTM B280 and clean, dehydrate and seal. Provide seamless copper tubing suction headers or seamless or resistance welded steel tube suction headers with copper connections. Provide supply headers that consist of a distributor which distributes the refrigerant through seamless copper tubing equally to all circuits in the coil. Provide circuited tubes to ensure minimum pressure drop and maximum heat transfer. Provide circuiting that permits refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Provide field installed coils which are completely dehydrated and sealed at the factory upon completion of pressure tests. Pressure test coils in accordance with UL 1995.

2.10.2.2 Water Coils

Install water coils with a pitch of not less than 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of cast iron, welded steel or copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans. Pressure test coils in accordance with UL 1995.

2.10.2.3 Steam Heating Coils

Construct steam coils from cast semisteel, welded steel or copper headers, and [red brass][copper] tubes. Construct headers from cast iron, welded steel or copper. Provide fin tube and header section that float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide each coil with a field or factory installed vacuum breaker. Provide single-tube type coils with tubes not less than 1/2 inch outside diameter, except for steam preheat coils. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with a maximum variation of no more than 5 percent. Pressure testcoils in accordance with UL 1995.

2.10.2.4 Steam Preheat (Nonfreeze) Coils

Provide steam-distribution-tube type steam (nonfreeze) coils with condensing tubes not less than 1 inch outside diameter for tube lengths 60 inches and over and 1/2 inch outside diameter for tube lengths under 60 inches. Construct headers from cast iron, welded steel, or copper. Provide distribution tubes that are not less than 5/8 inch outside diameter for tube lengths 60 inches and over and 3/8 inch outside diameter for tube lengths under 60 inches with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes and hold securely in alignment. Limit maximum length of a single coil to 144 inches. Factory test coils to ensure that, when supplied with a uniform face velocity, temperature across the leaving side is uniform with

a maximum variation of no more than 5 percent. Pressure test coils in accordance with UL 1995.

2.10.3 Air Filters

List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586.

2.10.3.1 Extended Surface Pleated Panel Filters

Provide 2 inch depth, sectional, disposable type filters of the size indicated with a MERV of 8 when tested according to ASHRAE 52.2. Provide initial resistance at 500 fpm that does not exceed 0.36 inches water gauge. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.10.3.2 Extended Surface Nonsupported Pocket Filters

Provide [30] [____] inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [500] [___] fpm that does not exceed [0.45] [___] inches water gauge. Provide UL Class 1 filters. Provide fibrous glass media, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Provide pockets that do not sag or flap at anticipated air flows. Install each filter [with an extended surface pleated panel filter as a prefilter] in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.10.3.3 Cartridge Type Filters

Provide 12 inch depth, sectional, replaceable dry media type filters of the size indicated with a MERV of 13 when tested according to ASHRAE 52.2. Provide initial resistance at [500] [____] fpm that does not exceed [0.56] [____] inches, water gauge. Provide UL class 1 filters, and pleated microglass paper media with corrugated aluminum separators, sealed inside the filter cell to form a totally rigid filter assembly. Fluctuations in filter face velocity or turbulent airflow have no effect on filter integrity or performance. Install each filter [with an extended surface pleated media panel filter as a prefilter] in a factory preassembled side access housing, or a factory-made sectional frame bank, as indicated.

2.10.3.4 Sectional Cleanable Filters

Provide [1][2] inch thick cleanable filters. Provide viscous adhesive in 5 gallon containers in sufficient quantity for 12 cleaning operations and not less than one quart for each filter section. Provide one washing and charging tank for every 100 filter sections or fraction thereof; with each washing and charging unit consisting of a tank and [single][double] drain rack mounted on legs and drain rack with dividers and partitions to properly support the filters in the draining position.

2.10.3.5 Replaceable Media Filters

Provide the [dry-media][viscous adhesive] type replaceable media filters, of the size required to suit the application. Provide filtering media that

is not less than 2 inches thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Enclose pad in a holding frame of not less than 16 gauge galvanized steel, equipped with quick-opening mechanism for changing filter media. Base the air flow capacity of the filter on net filter face velocity not exceeding [300][___] fpm, with initial resistance of [0.13][___] inches water gauge. Provide MERV that is not less than [___] when tested according to ASHRAE 52.2.

2.10.3.6 Automatic Renewable Media Filters

Provide the following:

- a. Automatic, renewable media filters consisting of a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass supplied in convenient roll form, and filter that does not require water supply, sewer connections, adhesive reservoir, or sprinkler equipment as part of the operation and maintenance requirements.
- b. Basic frame that is fabricated of not less than 14 gauge galvanized steel, and sectional design filters with each section of each filter fully factory assembled, requiring no field assembly other than setting in place next to any adjacent sections and the installation of media in roll form.
- c. Each filter complete with initial loading of filter media drive motor adequate to handle the number of sections involved, and [painted steel] [stainless steel] control box containing a warning light to indicate media runout, a runout switch, and a Hand-Off-Auto selector switch.
- d. Media feed across the filter face in [full-face increments] [increments] automatically controlled as determined by [filter pressure differential] [time interval control] [time interval control with pressure override] [photo electric control] to provide substantially constant operating resistance to airflow and varying not more than plus or minus 10 percent. Roll or enclose media in such a way that collected particulates can not re-entrain.
- e. Rolls of clean media, no less than 65 feet long, rerolled on disposable spools in the rewind section of the filter after the media has accumulated its design dirt load. Equip rewind section with a compression panel to tightly rewind used media for ease of handling. Provide media made of continuous, bonded fibrous glass material, UL Class 2, that does not compress more than 1/4 inch when subjected to air flow at 500 fpm. Factory charge media with an odorless and flame retardant adhesive which does not flow while in storage nor when subjected to temperatures up to 175 degrees F. Support media on both the leaving and entering air faces. Clean media must have initial resistance that does not exceed 0.18 inch water gauge at its rated velocity of 500 fpm. Set control so that the resistance to air flow is between 0.40-and 0.50 inch water gauge unless otherwise indicated.
- f. Dust holding capacity, of 80 percent average arrestance under these operating conditions, when operating at a steady state with an upper operating resistance of 0.50 inch water gauge, that is at least 592 (55) grams of ASHRAE Standard Test Dust per square foot of media area, when tested according to the dynamic testing provisions of ASHRAE 52.2.
- g. The horizontal type automatic renewable media filters, when used in conjunction with factory fabricated air handling units, that are

dimensionally compatible with the connecting air handling units, and horizontal type filter housings with all exposed surfaces factory insulated internally with 1 inch, 1-1/2 pound density neoprene coated fibrous glass with thermal conductivity not greater than 0.27 Btu/hour/degree F/square foot/inch of thickness.

- h. Access doors for horizontal filters with double wall construction as specified for plenums and casings for field-fabricated units in paragraph DUCT SYSTEMS.
- 2.10.3.7 Electrostatic Filters

Provide the following:

- a. The combination dry agglomerator/extended surface, nonsupported pocket electrostatic filters or the combination dry agglomerator/automatic renewable, media (roll) type electrostatic filters, as indicated (except as modified). Supply each dry agglomerator electrostatic air filter with the correct quantity of fully housed power packs and equip with silicon rectifiers, manual reset circuit breakers, low voltage safety cutout, relays for field wiring to remote indication of primary and secondary voltages, with lamps mounted in the cover to indicate these functions locally. Equip power pack enclosure with external mounting brackets, and low and high voltage terminals fully exposed with access cover removed for ease of installation. Furnish interlock safety switches for each access door and access panel that permits access to either side of the filter, so that the filter is de-energized in the event that a door or panel is opened.
- b. Ozone generation within the filter that does not exceed five parts per one hundred million parts of air. Locate high voltage insulators in a serviceable location outside the moving air stream or on the clean air side of the unit. Fully expose ionizer wire supports and furnish ionizer wires precut to size and with formed loops at each end to facilitate ionizer wire replacement.
- c. Agglomerator cell plates that allow proper air stream entrainment of agglomerates and prevent excessive residual dust build-up, with cells that are open at the top and bottom to prevent accumulation of agglomerates which settle by gravity. Where the dry agglomerator electrostatic filter is indicated to be the automatic renewable media type, provide a storage section that utilizes a horizontal or vertical traveling curtain of adhesive-coated bonded fibrous glass for dry agglomerator storage section service supplied in 65 foot lengths in convenient roll form. Otherwise, provide section construction and roll media characteristics as specified for automatic renewable media filters. Also a dry agglomerator/renewable media combination with an initial air flow resistance, after installation of clean media, that does not exceed 0.25 inch water gauge at 500 fpm face velocity.
- d. A MERV of the combination that is not less than 15 when tested according to ASHRAE 52.2 at an average operating resistance of 0.50 inch water gauge. Where the dry agglomerator electrostatic filter is indicated to be of the extended surface nonsupported pocket filter type, provide a storage section as specified for extended surface non-supported pocket filters, with sectional holding frames or side access housings as indicated.
- e. A dry agglomerator/extended surface nonsupported pocket filter section

combination with initial air flow resistance, after installation of clean filters, that does not exceed 0.65 inch water gauge at 500 fpm face velocity, with a MERV of the combination not less than 16 when tested according to ASHRAE 52.2. Furnish front access filters with full height air distribution baffles and upper and lower mounting tracks to permit the baffles to be moved for agglomerator cell inspection and service. When used in conjunction with factory fabricated air handling units, supply side access housings which have dimensional compatibility.

2.10.3.8 High-Efficiency Particulate Air (HEPA) Filters

Provide HEPA filters that meet the requirements of IEST RP-CC-001 and are individually tested and certified to have an efficiency of not less than [95] [99.97] percent, and an initial resistance at [____] fpm that does not exceed [] inches water gauge. Provide filters that are constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by corrugated aluminum or mineral-fiber inserts, strips of filter medium, or by honeycomb construction of the pleated filter medium. Provide interlocking, dovetailed, molded neoprene rubber gaskets of 5-10 durometer that are cemented to the perimeter of the [upstream] [downstream] face of the filter cell sides. Provide self-extinguishing rubber-base type adhesive or other materials conforming to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Provide filter cell sides that are [3/4 inch thick exterior grade fire-retardant plywood] [cadmium plated steel] [galvanized steel] assembled in a rigid manner. Provide overall cell side dimensions that are correct to 1/16 inch, and squareness that is maintained to within 1/8 inch. Provide holding frames that use spring loaded fasteners or other devices to seal the filter tightly within it and that prevent any bypass leakage around the filter during its installed life. Provide air capacity and the nominal depth of the filter as indicated. Install each filter in a factory preassembled side access housing or a factory-made sectional supporting frame as indicated. Provide prefilters of the type, construction and efficiency indicated.

2.10.3.9 Holding Frames

Fabricate frames from not lighter than 16 gauge sheet steel with rust-inhibitor coating. Equip each holding frame with suitable filter holding devices. Provide gasketed holding frame seats. Make all joints airtight.

2.10.3.10 Filter Gauges

Provide dial type filter gauges, diaphragm actuated draft for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Provide gauges that are at least 3-7/8 inches in diameter, with white dials with black figures, and [graduations] [graduated in 0.01 inch of water,] with a minimum range of 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Provide each gauge with a screw operated zero adjustment and two static pressure tips with integral compression fittings, two molded plastic vent valves, two 5 foot minimum lengths of 1/4 inch diameter [aluminum] [vinyl] tubing, and all hardware and accessories for gauge mounting.

2.11 AIR HANDLING UNITS

2.11.1 Field-Fabricated Air Handling Units

Provide built-up units as specified in paragraph DUCT SYSTEMS. Provide fans, coils spray-coil dehumidifiers, and air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.11.2 Factory-Fabricated Air Handling Units

Provide [single-zone draw-through type][or][single-zone blow-through type][or][multizone blow-through type][blow-through double-deck type][blow-through triple deck type] units as indicated. Units must include fans, coils, airtight insulated casing, [prefilters,] [secondary filter sections,][and][diffuser sections where indicated,] [air blender] adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, [mixing box] [combination sectional filter-mixing box,] [[pan][drysteam][spray type] humidifier,] vibration-isolators, and appurtenances required for specified operation. Provide vibration isolators as indicated. Physical dimensions of each air handling unit must be suitable to fit space allotted to the unit with the capacity indicated. Provide air handling unit that is rated in accordance with AHRI 430 and AHRI certified for cooling.

2.11.2.1 Casings

Provide the following:

- a. [Casing sections [[single] [2 inch double] wall type] [as indicated], constructed of a minimum 18 gauge galvanized steel, or 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304.][Inner casing of double-wall units that are a minimum 20 gauge solid galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304.] Design and construct casing with an integral insulated structural galvanized steel frame such that exterior panels are non-load bearing.
- b. Individually removable exterior panels with standard tools. Removal must not affect the structural integrity of the unit. Furnish casings with access sections, according to paragraph AIR HANDLING UNITS, inspection doors, and access doors, all capable of opening a minimum of 90 degrees, as indicated.
- c. Insulated, fully gasketed, double-wall type inspection and access doors, of a minimum 18 gauge outer and 20 gauge inner panels made of either galvanized steel or corrosion-resisting sheet steel conforming to ASTM A167, Type 304. Provide rigid doors with heavy duty hinges and latches. Inspection doors must be a minimum 12 inches wide by 12 inches high. Access doors must be a minimum 24 inches wide, the full height of the unit casing or a minimum of 6 foot, whichever is less. [Install a minimum 8 by 8 inches sealed glass window suitable for the intended application, in all access doors.]
- d. Double-wall insulated type drain pan (thickness equal to exterior casing) constructed of 16 gauge [galvanized steel] [corrosion resisting sheet steel conforming to ASTM A167, Type 304], conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other,

condensate from the upper coils must not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Construct drain pan to allow for easy visual inspection, including underneath the coil without removal of the coil and to allow complete and easy physical cleaning of the pan underneath the coil without removal of the coil. Provide coils that are individually removable from the casing.

- e. Casing insulation that conforms to NFPA 90A. Insulate single-wall casing sections handling conditioned air with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Insulate double-wall casing sections handling conditioned air with not less than 2 inches of the same insulation specified for single-wall casings. Foil-faced insulation is not an acceptable substitute for use with double wall casing. Seal double wall insulation completely by inner and outer panels.
- f. Factory applied fibrous glass insulation that conforms to ASTM C1071, except that the minimum thickness and density requirements do not apply, and that meets the requirements of NFPA 90A. Make air handling unit casing insulation uniform over the entire casing. Foil-faced insulation is not an acceptable substitute for use on double-wall access doors and inspections doors [and casing sections].
- g. Duct liner material, coating, and adhesive that conforms to fire-hazard requirements specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Protect exposed insulation edges and joints where insulation panels are butted with a metal nosing strip or coat to meet erosion resistance requirements of ASTM C1071.
- A latched and hinged inspection door, in the fan and coil sections.
 Plus additional inspection doors, access doors and access sections
 [][where indicated].
- 2.11.2.2 Heating and Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.11.2.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.11.2.4 Fans

Provide the following:

- a. Fans that are double-inlet, centrifugal type with each fan in a separate scroll. Dynamically balance fans and shafts prior to installation into air handling unit, then after it has been installed in the air handling unit, statically and dynamically balance the entire fan assembly. Mount fans on steel shafts, accurately ground and finished.
- b. Fan bearings that are sealed against dust and dirt and are precision self-aligning ball or roller type, with L50 rated bearing life at not

less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide bearings that are permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Support bearings by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Do not fasten bearings directly to the unit sheet metal casing. Furnish fans and scrolls with coating indicated.

- c. Fans that are driven by a unit-mounted, or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Furnish belt guards that are the three-sided enclosed type with solid or expanded metal face. Design belt drives for not less than a 1.3 service factor based on motor nameplate rating.
- d. [Motor sheaves that are variable pitch for 25 hp and below and fixed pitch above 25 hp as defined by AHRI Guideline D.] Where fixed sheaves are required, the use of variable pitch sheaves is allowed during air balance, but replace them with an appropriate fixed sheave after air balance is completed. Select variable pitch sheaves to drive the fan at a speed that produces the specified capacity when set at the approximate midpoint of the sheave adjustment. Furnish motors for V-belt drives with adjustable bases, and with [open][splashproof][totally enclosed] enclosures.
- e. Motor starters of

[manual][magnetic][across-the-line][reduced-voltage-start] type with [general-purpose][weather-resistant][watertight] enclosure. Select unit fan or fans to produce the required capacity at the fan static pressure with sound power level as indicated. Obtain the sound power level values according to AMCA 300, ASHRAE 68, or AHRI 260 I-P.

2.11.2.5 Access Sections and Filter/Mixing Boxes

Provide access sections where indicated and furnish with access doors as shown. Construct access sections and filter/mixing boxes in a manner identical to the remainder of the unit casing and equip with access doors. Design mixing boxes to minimize air stratification and to promote thorough mixing of the air streams.

2.11.2.6 Diffuser Sections

Furnish diffuser sections between the discharge of all housed supply fans [and cooling coils of blow-through single zone units][and][filter sections of those units with high efficiency filters located immediately downstream of the air handling unit fan section]. Provide diffuser sections that are fabricated by the unit manufacturer in a manner identical to the remainder of the unit casing, designed to be airtight under positive static pressures up to [8][____] inches water gauge and with an access door on each side for inspection purposes. Provide a diffuser section that contains a perforated diffusion plate, fabricated of galvanized steel, Type 316 stainless steel, aluminum, or steel treated for corrosion with manufacturer's standard corrosion-resisting finish, and designed to accomplish uniform air flow across the down-stream [coil][filters] while reducing the higher fan outlet velocity to within plus or minus 5 percent of the required face velocity of the downstream component.

2.12 TERMINAL UNITS

2.12.1 Room Fan-Coil Units

Provide base units that include galvanized coil casing, coil assembly drain pan [valve and piping package,] [outside air damper,] [wall intake box,] air filter, fans, motor, fan drive, motor switch, an enclosure for cabinet models and casing for concealed models, leveling devices integral with the unit for vertical type units, and sound power levels as indicated. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models are acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Fasten each unit securely to the building structure. Provide units with capacity indicated. Provide room fan-coil units that are certified as complying with AHRI 440, and meet the requirements of UL 1995.

2.12.1.1 Enclosures

Fabricate enclosures from not lighter than 18 gauge steel, reinforced and braced. Provide enclosures with front panels that are removable and have 1/4 inch closed cell insulation or 1/2 inch thick dual density foil faced fibrous glass insulation. Make the exposed side of a high density, erosion-proof material suitable for use in air streams with velocities up to

4,500 fpm. Provide a discharge grille that is [adjustable] [fixed] and that is of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material complies with the heat deflection criteria specified in UL 1995. Provide galvanized or factory finished ferrous metal surfaces with corrosion resistant enamel, and access doors or removable panels for piping and control compartments, plus easy access for filter replacement. Provide duct discharge collar for concealed models.

2.12.1.2 Fans

Provide steel or aluminum, multiblade, centrifugal type fans. In lieu of metal, fans and scrolls could be of non-metallic materials of suitably reinforced compounds with smooth surfaces. Dynamically and statically balance the fans. Provide accessible assemblies for maintenance. Disassemble and re-assemble by means of mechanical fastening devices and not by epoxies or cements.

2.12.1.3 Coils

Fabricate coils from not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Provide coils with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 300 psi or under water at 250 psi air pressure. Provide coils suitable for 200 psi working pressure. Make provisions for coil removal.

2.12.1.4 Drain Pans

Size and locate drain and drip pans to collect all water condensed on and dripping from any item within the unit enclosure or casing. Provide condensate drain pans designed for self-drainage to preclude the buildup of microbial slime and thermally insulated to prevent condensation and constructed of not lighter than 21 gauge type 304 stainless steel or noncorrosive ABS plastic. Provide insulation with a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and of a waterproof type or coated with a waterproofing material. Design drain pans so as to allow no standing water and pitch to drain. Provide minimum 3/4 inch NPT or 5/8 inch OD drain connection in drain pan. Provide plastic or metal auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages; if metal, provide auxiliary pans that comply with the requirements specified above. Extend insulation at control and piping connections 1 inch minimum over the auxiliary drain pan.

2.12.1.5 Manually Operated Outside Air Dampers

Provide manually operated outside air dampers according to the arrangement indicated, and parallel airfoil type dampers of galvanized construction. Provide blades that rotate on stainless steel or nylon sleeve bearings.

2.12.1.6 Filters

Provide disposable type filter that complies with ASHRAE 52.2. Provide filters in each unit that are removable without the use of tools.

2.12.1.7 Motors

Provide motors of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Provide motor switch with two or three speeds and off, manually operated, and mounted on an identified plate [inside the unit below or behind an access door][or][adjacent to the room thermostat][as indicated]. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent is allowed. Provide motors with permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Provide a motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity that does not exceed the following values:

Free Discharge Motors				
Unit Capacity (cfm)	Maximum Power Consumption (Watts)			
	115V	230V	277V	
200	70	110	90	
300	100	110	110	
400	170	150	150	

Free Discharge Motors				
Unit Capacity (cfm)	Maximum Power Consumption (Watts)			
	115V	230V	277V	
600	180	210	220	
800	240	240	230	
1000	310	250	270	
1200	440	400	440	

High Static Motors			
Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
200	145		
300	145		
400	210		
600	320		
800	320		
1000	530		
1200	530		

2.12.2 Coil Induction Units

Provide base unit that includes air plenums, air-discharge nozzles, air discharge grilles, recirculation grilles, water coil assembly, valve and piping package, condensate drain pan, and adjustable air-balancing dampers, plus an enclosure for cabinet models and casing for concealed models. Make each unit capable of producing not less than the capacity indicated without exceeding the indicated static pressure. Provide a sound power level as indicated with power level data or values for these units based on tests conducted according to ASA S12.51. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. The values obtained for the standard cabinet models are acceptable for concealed models without separate tests, provided there is no variation between models as to coil configuration, air discharge nozzles, air balancing dampers, or relative arrangement of parts. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Secure each unit to the building structure. Provide units with capacity indicated.

2.12.2.1 Enclosures

Fabricate enclosures from not lighter than 18 gauge steel, reinforced and braced. Provide a removable front panel of enclosure and insulate when required acoustically and to prevent condensation. Provide discharge grilles that are [adjustable][integrally stamped] and properly distribute air throughout the conditioned space. Plastic discharge and return grilles are not acceptable. Provide access doors for all piping and control compartments.

2.12.2.2 Air Plenums

Fabricate plenums from galvanized steel with interior acoustically baffled and lined with sound absorbing material to attenuate the sound power from the primary air supply to the room. Provide heat-resistant nozzles that are integral with or attached airtight to the plenum. Where coil induction units are supplied with vertical runouts, furnish a streamlined, vaned, mitered elbow transition piece for connection between the unit and ductwork. Provide an adjustable air-balancing damper in each unit.

2.12.2.3 Coils

Fabricate coils from not less than 3/8 inch outside diameter seamless copper tubing, with copper or aluminum fins, mechanically bonded or soldered to the tubes. Furnish coil connections with not less than 1/2 inch outside diameter flare or sweat connectors, accessory piping package with terminal connections suitable for connection to the type of control valve supplied, and manual air vent. Test coils hydrostatically at 300 psi or under water at 250 psi air pressure and provide coils suitable for 200 psi working pressure.

2.12.2.4 Screens

Provide easily accessible lint screens or throwaway filters for each unit.

2.12.2.5 Drain Pan

Size and locate drain and drip pans to collect condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 21 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that has a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and that is a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans constructed of die-formed 22 gauge steel are allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 21 gauge steel material or of die-formed 21 gauge type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Provide drain connection when a condensate drain system is indicated. Make connection a minimum 3/4 inch NPT or 5/8 inch OD.

2.12.3 Variable Air Volume (VAV) and Dual Duct Terminal Units

a. Provide VAV and dual duct terminal units that are the type, size, and capacity shown, mounted in the ceiling or wall cavity, plus units that are suitable for single or dual duct system applications. Provide actuators and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

- b. Provide unit enclosures that are constructed of galvanized steel not lighter than 22 gauge or aluminum sheet not lighter than 18 gauge. Provide single or multiple discharge outlets as required. Units with flow limiters are not acceptable. Provide unit air volume that is factory preset and readily field adjustable without special tools. [Provide reheat coils as indicated.]
- c. Attach a flow chart to each unit. Base acoustic performance of the terminal units upon units tested according to AHRI 880 I-P with the calculations prepared in accordance with AHRI 885. Provide sound power level as indicated. Show discharge sound power for minimum and [1-1/2][___] inches water gauge inlet static pressure. Provide acoustical lining according to NFPA 90A.

2.12.3.1 Constant Volume, Single Duct Terminal Units

Provide constant volume, single duct, terminal units that contain within the casing, a constant volume regulator. Provide volume regulators that control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 3/4 to 6 inch water gauge.

2.12.3.2 Variable Volume, Single Duct Terminal Units

Provide variable volume, single duct, terminal units with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Provide units that control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 3/4 to 6 inch water gauge. Provide units with an internal resistance not exceeding 0.4 inch water gauge at maximum flow range. Provide external differential pressure taps separate from the control pressure taps for air flow measurement with a 0 to 1 inch water gauge range.

2.12.3.3 Variable Volume, Single Duct, Fan-Powered Terminal Units

Provide variable volume, single duct, fan-powered terminal units with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Provide units that control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 3/4 to 6 inch water gauge. Provide unit fan that is centrifugal, direct-driven, double-inlet type with forward curved blades. Provide either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type fan motor. Isolate fan/motor assembly from the casing to minimize vibration transmission. Provide factory furnished fan control that is wired into the unit control system. Provide a factory-mounted pressure switch to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.12.3.4 Dual Duct Terminal Units

Provide dual duct terminal units with hot and cold inlet valve or dampers that are controlled in unison by single or dual actuators. Provide actuator as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Provide unit that controls delivered air volumes within plus or minus 5 percent with inlet air variations from 1 to 8 inch water gauge in either duct. Include mixing baffles with the unit casing. Provide cabinet and closed duct leakage that does not exceed 2 percent of maximum rated air volume. Provide units with an internal resistance that

does not exceed [____] inch water gauge at maximum flow range.

2.12.3.5 Ceiling Induction Terminal Units

Provide ceiling induction unit with a calibrated primary air volume sensing device, primary air valve, induced air damper, and insulated induction tube. Arrange unit to induce air from the ceiling plenum to maintain a maximum total flow circulated to the conditioned space. Vary primary air upon demand of the room thermostat. Upon a demand for maximum cooling, provide a unit that delivers 100 percent primary air and, at minimum cooling, delivers [50] [25] percent primary air. Provide a terminal unit capable of closing to full shut off without additional actuators or linkage changes. Provide terminals that reset primary air volume within plus or minus 5 percent determined by the thermostat regardless of upstream changes in the static pressure. Provide a minimum inlet static pressure that does not exceed 1 inch water gauge, including a maximum of 0.3 inch water gauge downstream static pressure. Provide external differential pressure taps separate from control pressure taps for primary air flow measurement with 0 to 1 inch water gauge range. Make each unit normally [open] [closed] upon loss of pneumatic pressure. Factory pipe actuator and accuracy controls requiring only field installation of 20 psi pneumatic main air and room thermostat.

2.12.3.6 Series Fan Powered Variable Air Volume (VAV) Terminals

Provide units factory assembled, designed, tested, rated in accordance with AHRI 880 I-P, that are AHRI certified, listed in the AHRI DCAACP and that produce a supply air discharge mix by modulation of conditioned primary air and recirculating of return air. Provide units that include casing, centrifugal fan and motor, primary VAV damper or valve, electronic volume regulator, discharge air damper, primary air inlet cone with high and low pressure flow sensors, recirculating air filter frames, filter, and electrical disconnect. [Provide hot water heating coils integral to the terminal, or provide insulated hot water coil section attached to the discharge of the terminal.]

2.12.3.6.1 Casing

Provide removable full bottom access panels for servicing internal components without disturbing duct connections. Insulate inside of casing with manufacturer's standard insulation. Provide units that have recirculating air inlet equipped with filter frame, round primary damper or valve, and unit mounting brackets.

2.12.3.6.2 Fans and Motors

Provide centrifugal, forward curved, multiblade, fan wheels with direct-drive motors. Provide motors that are the high efficiency permanent-split capacitor type with thermal overload protection, permanently lubricated bearings, and have three speeds or are equipped with solid state speed controllers. Provide isolation between fan motor assembly and unit casing. Provide fan and motor that is removable through casing access panel.

2.12.3.6.3 Flow Sensor

Provide ring or cross type sensor with minimum of two pickup points which average the velocity across the inlet. Obtain flow measurement within plus or minus 5 percent of rated airflow with 1.5 diameters of straight duct

upstream of unit and inlet static variation of 0.5 to 5.0 inches water gauge. Supply flow measuring taps and calibration flowchart with each unit for field balancing airflows.

2.12.3.6.4 Primary VAV Damper or Valve

Provide galvanized steel damper blade that closes against gasket inside unit. Connect damper to operating shaft with a positive mechanical connection. Provide nylon bearing for damper shaft. Cylindrical die cast aluminum valve inlet tapered to fit round flexible ducts with integral flow diffuser and beveled self-centering disc. Provide damper or valve leakage at shutoff that does not exceed 2 percent of capacity at 1 inch water gauge pressure.

2.12.3.6.5 Regulator

Provide electronic volume regulator. Electronic controls contained in NEMA ICS 6, Type 1 enclosure sealed from airflow. Provide unit with controls mounted on side or on air valve. System powered regulators are not permitted. Provide volume regulator that resets primary air volume as determined by thermostat, within upstream static pressure variation noted in paragraph titled "Flow Sensor." Provide volume regulators that are field adjustable, factory set and calibrated to indicated maximum and minimum primary airflows, direct acting and normally [open] [closed] upon loss of pneumatic pressure.

2.12.3.6.6 Electrical

Provide unit that incorporates single point electrical connection with electrical disconnect. Provide electrical components that are UL or ETL listed, installed in accordance with NFPA 70 and mounted in control box. Units UL or ETL listed as an assembly do not require airflow switch interlock with electric heating coil, when factory assembled.

2.12.3.6.7 Filters

Provide UL listed throwaway one inch thick fiberglass filters, standard dust-holding capacity.

2.12.3.7 Reheat Units

2.12.3.7.1 Hot Water Coils

Provide fin-and-tube type hot-water coils constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Provide headers that are constructed of cast iron, welded steel or copper. Provide casing and tube support sheets that are 16 gauge, galvanized steel, formed to provide structural strength. Provide tubes that are correctly circuited for proper water velocity without excessive pressure drop and are drainable where required or indicated. At the factory, test each coil at not less than 250 psi air pressure and provide coils suitable for 200 psi working pressure. Install drainable coils in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils must conform to the provisions of AHRI 410.

2.12.3.7.2 Steam Coils

Provide steam coils constructed of cast semisteel, welded steel, or copper

headers, red-brass or copper tubes, and copper or aluminum fins mechanically bonded or soldered to the tubes. Roll and bush, braze or weld tubes into headers. Provide coil casings and tube support sheets, with collars of ample width, that are not lighter than 16 gauge galvanized steel formed to provide structural strength. When required, furnish multiple tube supports to prevent tube sag. Float the fin tube and header section within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Provide coils that are factory pressure tested and capable of withstanding 250 psi hydrostatic test pressure or 250 psi air pressure, and are for [100] [200] psi steam working pressure. Provide steam-distribution tube type preheat coils with condensing tubes having not less than 5/8 inch outside diameters. Provide distribution tubes that have not less than 3/8 inch outside diameter, with orifices to discharge steam to condensing tubes. Install distribution tubes concentric inside of condensing tubes held securely in alignment. Limit the maximum length of a single coil to 120 times the diameter of the outside tube. Other heating coils must be single tube type with an outside diameter not less than 1/2 inch. Provide supply headers that distribute steam evenly to all tubes at the indicated steam pressure. Provide coils that conform to the provisions of AHRI 410.

2.12.3.7.3 Electric Resistance Heaters

Provide the duct-mounting type electric resistance heaters consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Provide electric duct heater that meets the requirement of Underwriters Laboratories and NFPA 70 and is provided with a built-in or surface-mounted high-limit thermostat. Interlock electric duct heaters electrically so that they cannot be energized unless the fan is running.

2.12.4 Unit Ventilators

Provide unit ventilators that include an enclosure, [galvanized casing,] [cold-rolled steel casing with corrosion resistant coating,] coil assembly, [resistance heating coil assembly,] [valve and piping package,] drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, damper operators, and sound power level as indicated. Obtain sound power level data or values for these units according to test procedures based on AHRI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Secure each unit to the building structure. Provide the unit ventilators with capacity indicated. Provide the year-round classroom type unit ventilator with automatic controls arranged to properly heat, cool, and ventilate the room. Provide automatic valves and controls as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS. Make the sequence of control any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.12.4.1 Enclosures

Fabricate enclosures from not lighter than 16 gauge galvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. Provide casing that is acoustically and thermally insulated internally with not less than 1/2 inch thick dual density fibrous glass insulation. Make the exposed side a high density, erosion-proof material suitable for use in air streams with velocities up to 4500 fpm. Fasten the insulation with waterproof, fire-resistant adhesive. Design front panel for easy removal by one person. Provide discharge grilles that

[have adjustable grilles or grilles with adjustable vanes and] properly distribute air throughout the conditioned space. Provide return grilles that are removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Furnish removable panels or access doors for all piping and control compartments. Provide fan switch that is key operated or accessible through a locked access panel. Install gaskets at the back and bottom of the unit for effective air seal, as required.

2.12.4.2 Electric Resistance Heating Elements

Provide electric resistance heating elements that are of the sheathed, finned, tubular type, or of the open resistance type designed for direct exposure to the air stream. Provide heating element electrical characteristics as indicated. Where fan motor or control voltage is lower than required for the electric-resistance heating element, install a fused factory mounted and wired transformer.

2.12.4.3 Fans

Provide fans that meet the requirements as specified in paragraph AIR SYSTEMS EQUIPMENT. Provide galvanized steel or aluminum, multiblade, centrifugal type fans, dynamically and statically balanced. Equip fan housings with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Provide direct-connected fans.

2.12.4.4 Coils

Provide coils that are circuited for a maximum water velocity of 8 fps without excessive pressure drop and are otherwise as specified for hot water coils in paragraph TERMINAL UNITS.

2.12.4.5 Drain Pans

Size and locate drain and drip pans to collect all condensed water dripping from any item within the unit enclosure. Provide drain pans constructed of not lighter than 18 gauge steel, galvanized after fabrication, and thermally insulated to prevent condensation. Provide insulation that is coated with a fire-resistant waterproofing material. In lieu of the above, drain pans constructed of die-formed 20 gauge steel is allowed, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 18 gauge steel material, or of die-formed 18 gauge type 304 stainless steel insulated as specified above. Pitch drain pans to drain. Furnish drain connection unless otherwise indicated. Make the minimum connection 3/4 inch NDT or 5/8 inch OD.

2.12.4.6 Filters

Disposable type rated in accordance with ASHRAE 52.2, installed upstream of coil.

2.12.4.7 Dampers

Provide an outside air proportioning damper on each unit. In addition, provide a vane to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning

dampers are provided on the unit, an additional vane is not required. Provide face and bypass dampers for each unit to ensure constant air volume at all positions of the dampers. Furnish each unit with a factory installed control cam assembly, pneumatic motor, or electric motor to operate the face and bypass dampers and outside air damper or outside air and recirculated air dampers in the sequence as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.12.4.8 Motors

Provide permanent split-capacitor type motors with built-in thermal overload protection and automatic reset. Mount motor on a resilient mounting, isolated from the casing and suitable for operation on electric service available. Provide a manually operated motor switch that provides for 2 or 3 speeds and off, mounted on an identified plate [inside the unit below or behind an access door] [or] [adjacent to the room thermostat] [as indicated]. In lieu of speed control, provide a solid state variable speed controller having minimum speed reduction of 50 percent.

2.12.4.9 Outside Air Intakes

Provide the manufacturer's standard design outside air intakes furnished with 1/2 inch mesh bird screen or louvers on 1/2 inch centers.

2.13 ENERGY RECOVERY DEVICES

2.13.1 Rotary Wheel

Provide unit that is a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream, with device performance according to ASHRAE 84 and that delivers an energy transfer effectiveness of not less than [70][85][___] percent with cross-contamination not in excess of [0.1][1.0][___] percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Provide exchange media that is chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Isolate exhaust and supply streams by seals which are static, field adjustable, and replaceable. Equip chain drive mechanisms with ratcheting torque limiter or slip-clutch protective device. Fabricate enclosure from galvanized steel and include provisions for maintenance access. Provide recovery control and rotation failure provisions as indicated.

2.13.2 Run-Around-Coil

Provide assembly that is factory fabricated and tested air-to-liquid-to-air energy recovery system for transfer of sensible heat from exhaust air to supply air stream and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination with maximum energy recovery at minimum life cycle cost. Computer optimize components for capacity, effectiveness, number of coil fins per inch, number of coil rows, flow rate, heat transfer rate of [____] percent by volume of [ethylene][propylene] glycol solution, and frost control. Provide coils that conform to paragraph AIR HANDLING UNITS. Provide related pumps, and piping specialties that conform to requirements of [Section 23 63 00.00 COLD STORAGE REFRIGERATION SYSTEMS][Section 23 57 10.00 10 FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS][23 69 00.00 20 REFRIGERATION EQUIPMENT FOR COLD STORAGE] [____].

2.13.3 Heat Pipe

Provide a device that is a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams and that delivers an energy transfer effectiveness not less than that indicated without cross-contamination. Provide heat exchanger tube core that is [1/2][5/8][1] inch nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Provide maximum fins per unit length and number of tube rows as indicated. Provide tubes that are fitted with internal capillary wick, filled with a refrigerant complying with ASHRAE 15 & 34, selected for system design temperature range, and hermetically sealed. Refrigerants containing chlorofluorocarbons (CFC) are prohibited. Provide heat exchanger frame that is constructed of not less than 16 gauge galvanized steel and fitted with intermediate tube supports, and flange connections. Provide tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio.[Provide a drain pan constructed of welded Type 300 series stainless steel.] Provide heat recovery regulation by [system face and bypass dampers and related control system as indicated][interfacing with manufacturer's standard tilt-control mechanism for summer/winter operation, regulating the supply air temperature and frost prevention on weather face of exhaust side at temperature indicated]. Coil must be fitted with pleated flexible connectors.

2.13.4 Desiccant Wheel

Provide counterflow supply, regeneration airstreams, a rotary type dehumidifier designed for continuous operation, and extended surface type wheel structure in the axial flow direction with a geometry that allows for laminar flow over the operating range for minimum air pressure differentials. Provide the dehumidifier complete with a drive system utilizing a fractional-horsepower electric motor and speed reducer assembly driving the rotor. Include a slack-side tensioner for automatic take-up for belt-driven wheels. Provide an adsorbing type desiccant material. Apply the desiccant material to the wheel such that the entire surface is active as a desiccant and the desiccant material does not degrade or detach from the surface of the wheel which is fitted with full-face, low-friction contact seals on both sides to prevent cross leakage. Provide rotary structure that has underheat, overheat and rotation fault circuitry. Provide wheel assembly with a warranty for a minimum of five years.

2.13.5 Plate Heat Exchanger

Provide energy recovery ventilator unit that is factory-fabricated for indoor installation, consisting of a flat plate cross-flow heat exchanger, cooling coil, supply air fan and motor and exhaust air fan and motor. The casing must be 20 gauge G90, galvanized steel, double wall construction with one inch insulation. Provide fibrous desiccant cross-flow type heat exchanger core capable of easy removal from the unit.

2.14 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory

paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Field paint factory painting that has been damaged prior to acceptance by the Contracting Officer in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

- 2.15 SUPPLEMENTAL COMPONENTS/SERVICES
- 2.15.1 Chilled, Condenser, or Dual Service Water Piping

The requirements for chilled, condenser, or dual service water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.15.2 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.15.3 Water or Steam Heating System Accessories

The requirements for water or steam heating accessories such as expansion tanks and steam traps are specified in Section [23 52 00 HEATING BOILERS][23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM][23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS].

2.15.4 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section [22 00 00 PLUMBING, GENERAL PURPOSE][23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS] except as modified herein.

2.15.5 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.15.6 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.15.7 Controls

The requirements for controls are specified in [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS][and][Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC][and][Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS].

2.16 RADIANT PANELS

2.16.1 Hydronic Modular Panels

2.16.1.1 Panels

Modular radiant panels will fit into a standard 24 inch x 24 inch or 24 inch x 48 inch suspended T-Bar ceiling grid or flush mounted on a drywall ceiling. For flush mounted ceiling applications, the manufacturer will provide a one piece extruded aluminum frame. Panels must be supported from the T-bar assembly. Panels must be [14 gauge] or [16 gauge] extruded aluminum or sheet steel.

2.16.1.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.16.1.3 Water Tubes

Tubes must consist of ASTM B75/B75M [1/2 inch] [5/8 inch] O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. Heat pads will be used between the soldered fitting and the panel to protect the panel surface. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling). The panels will have the capacity to have multiple passes with connections either on the [same end] or [opposite ends], dependent on the number of passes.

2.16.1.4 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.16.1.5 Performance

Manufacturer will provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.16.1.6 Capacity

Modular radiant panel capacity will be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to meet the required performance. Should any performance rating, chilled or hot water supply temperature, water pressure drop, etc. deviate from the schedule, the manufacturer will submit the updated capacity. [The manufacturer will have factory testing facility available to perform performance test of units in accordance with said standard.]

2.16.1.7 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.16.1.8 Installation

Panels will be installed as recommended by the manufacturer.

2.16.1.9 Accessories

Stainless steel braded hoses, 12 inches or 18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 1-1/2 inches thick 1 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.16.2 Hydronic Linear Panels

2.16.2.1 Panels

Linear radiant panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face. The linear radiant panel is to radiate or absorb heat from or to the zone below. Panels must be [14 gauge] or [16 gauge] extruded aluminum.

2.16.2.2 Heat Sink

The modular panels must use extruded aluminum with integrated heat sinks on the back to transfer heat between copper tubes and the panel face.

2.16.2.3 Water Tubes

Tubes must consist of ASTM B75/B75M 1/2 inch or 5/8 inch O.D. nominal copper tubing. Water connections will be suitable for solder or compression fittings. The manufacturer will provide water pressure drop data as well as heating and cooling output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.16.2.4 Mounting

Units must be provided with mounting hardware as required for mounting in T-Bar applications or ceiling flush mounting. The manufacturer's standard hardware for mounting panels abutting each other must be submitted for approval.

2.16.2.5 Finish

All visible components must be powder coated with highly emissive powder coat polyester paint for optimal radiative properties as well as durability and easy cleaning. Standard finish color must be white.

2.16.2.6 Performance

Manufacturer must provide water pressure drop data as well as heat and cool output data derived from tests in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling).

2.16.2.7 Capacity

Modular radiant panel capacity must be tested and certified by manufacturer in accordance with DIN EN 14037 (heating) and DIN EN 14240 (cooling) to

meet the required performance. Should any performance rating, chilled or hot water supply temperature, water pressure drop, etc. deviate from the schedule, the manufacturer must submit the updated capacity. [The manufacturer must have factory testing facility available to perform performance test of units in accordance with said standard.]

2.16.2.8 Water Connections

Connections will be shipped sealed to limit the introduction of dust and dirt during shipping and construction.

2.16.2.9 Accessories

Stainless steel braded hoses, 12 inches or 18 inches long will be supplied with the panels.

The top of the heating and cooling panels must be covered with 1-1/2 inches thick 1 lb/cu ft formaldehyde-free fiber glass insulation with a minimum R = 4.5 (hr ft2 deg F)/BTU. The insulation must be covered with a foil scrim kraft vapor barrier facing.

2.16.3 Prefabricated Radiant-Heating Electric Panels

2.16.3.1 Description

Sheet metal enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting]. Comply with UL 2021

2.16.3.2 Panel

Minimum 0.027 inch thick, galvanized steel sheet back panel riveted to minimum 0.040 inch thick, galvanized steel sheet front panel with fused-on crystalline surface.

2.16.3.3 Heating Element

Powdered graphite sandwiched between sheets of electric insulation.

2.16.3.4 Electrical Connections

Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.

2.16.3.5 Exposed-Side Panel Finish

[Apply silk-screened finish to match appearance of Architect selected acoustical ceiling tiles.] [Baked-enamel finish in color as selected by Architect.]

2.16.3.6 Surface-Mounting Trim

Sheet metal with baked-enamel finish in color as selected by Architect.

2.16.3.7 Wall Thermostat

Bimetal, sensing elements; with contacts suitable for [low] [line]-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.
- b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of [3][___] feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices) and an additional [3][___] feet.
- c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all [units] [units except room [fan-coil units][and][coil-induction units]]. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than

6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph

DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 08 31 00 ACCESS DOORS AND PANELS.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.5.1 Underground Ductwork

Provide PVC plastisol coated galvanized steel underground ductwork with coating on interior and exterior surfaces and watertight joints. Install ductwork as indicated, according to ACCA Manual 4 and manufacturer's instructions. Maximum burial depth is 6 feet.

3.2.5.2 Radon Exhaust Ductwork

Perforate subslab suction piping where indicated. Install PVC joints as specified in ASTM D2855.

3.2.5.3 Light Duty Corrosive Exhaust Ductwork

For light duty corrosive exhaust ductwork, use PVC plastisol coated galvanized steel with PVC coating on interior [surfaces][and exterior surfaces][and epoxy wash primer coating on exterior surfaces].

3.2.6 FRP Ductwork

Provide fibrous glass reinforced plastic ducting and related structures that conform to SMACNA 1403. Provide flanged joints where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 50 degrees F, heat cure joints by exothermic reaction heat packs.

3.2.7 Kitchen Exhaust Ductwork

3.2.7.1 Ducts Conveying Smoke and Grease Laden Vapors

Provide ducts conveying smoke and grease laden vapors that conform to requirements of NFPA 96. Make seams, joints, penetrations, and duct-to-hood collar connections with a liquid tight continuous external weld. Provide duct material that is a [minimum 18 gauge, Type 304L or 316L, stainless steel] [minimum 16 gauge carbon steel]. [Include with duct construction an external perimeter angle sized in accordance with SMACNA 1966, except place welded joint reinforcement on maximum of 24 inch centers; continuously welded companion angle bolted flanged joints with flexible ceramic cloth gaskets where indicated; pitched to drain at low points; welded pipe coupling-plug drains at low points; welded fire protection and detergent cleaning penetration; steel framed, stud bolted, and flexible ceramic cloth gasketed cleaning access provisions where indicated. Make angles, pipe couplings, frames, bolts, etc., the same material as that specified for the duct unless indicated otherwise.]

3.2.7.2 Exposed Ductwork

Provide exposed ductwork that is fabricated from minimum 18 gauge, Type 304L or 316L, stainless steel with continuously welded joints and seams. Pitch ducts to drain at hoods and low points indicated. Match surface finish to hoods.

3.2.7.3 Concealed Ducts Conveying Moisture Laden Air

Fabricate concealed ducts conveying moisture laden air from minimum [18 gauge, Type 300 series, stainless steel] [16 gauge, galvanized steel] [16 ounce, tempered copper sheet]. Continuously weld, braze, or solder joints to be liquid tight. Pitch ducts to drain at points indicated. Make transitions to other metals liquid tight, companion angle bolted and gasketed.

3.2.8 Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I, NFPA 90A, UL 723, and ASTM E84. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.
3.2.9 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.10 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums [up to the point where the outdoor air reaches the conditioning unit][or][up to the point where the outdoor air mixes with the return air stream].

3.2.11 Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate location of test hole if needed for future use.

3.2.12 Power Roof Ventilator Mounting

Provide foamed 1/2 inch thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

3.2.13 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of [28][14][___] calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered

with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse [____] protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8

fasteners where the opening is 20 inches in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 FIELD PAINTING OF MECHANICAL EQUIPMENT

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except clean to bare metal on metal surfaces subject to temperatures in excess of 120 degrees F. Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Provide aluminum or light gray finish coat.

3.7.1 Temperatures less than 120 degrees F

Immediately after cleaning, apply one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat to metal surfaces subject to temperatures less than 120 degrees F.

3.7.2 Temperatures between 120 and 400 degrees F

Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

3.7.3 Temperatures greater than 400 degrees F

Apply two coats of 315 degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

3.7.4 Finish Painting

The requirements for finish painting of items only primed at the factory, and surfaces not specifically noted otherwise, are specified in Section 09 90 00 PAINTS AND COATINGS.

3.7.5 Color Coding Scheme for Locating Hidden Utility Components

Use scheme in buildings having suspended grid ceilings. Provide color coding scheme that identifies points of access for maintenance and operation of components and equipment that are not visible from the finished space and are accessible from the ceiling grid, consisting of a color code board and colored metal disks. Make each colored metal disk approximately 3/8 inch diameter and secure to removable ceiling panels with fasteners. Insert each fastener into the ceiling panel so as to be concealed from view. Provide fasteners that are manually removable without the use of tools and that do not separate from the ceiling panels when the panels are dropped from ceiling height. Make installation of colored metal disks are to

be fastened. Provide color code board that is approximately 3 foot wide, 30 inches high, and 1/2 inches thick. Make the board of wood fiberboard and frame under glass or 1/16 inch transparent plastic cover. Make the color code symbols approximately 3/4 inch in diameter and the related lettering in 1/2 inch high capital letters. Mount the color code board [where indicated] [in the mechanical or equipment room]. Make the color code system as indicated below:

Color	System	Item	Location
[]	[]	[]	[]

3.8 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.9 DUCTWORK LEAK TEST

Perform ductwork leak test for the entire air distribution and exhaust system, including fans, coils, [filters, etc.][filters, etc. designated as static pressure Class 3 inch water gauge through Class 10 inch water gauge.] Provide test procedure, apparatus, and report that conform to SMACNA 1972 CD. The maximum allowable leakage rate is [___] cfm. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior or concealing ductwork.

3.10 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.11 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.12 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.13 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of [room fan-coil units][coil-induction units,] [air terminal units,] [unit ventilators,] thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Perform and document that proper "Indoor Air Quality During Construction" procedures have been followed; provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.14 RADIANT PANELS

3.14.1 Installation

Install radiant panels level and plumb, maintaining sufficient clearance for normal services and maintenance.

3.14.2 Soldering

When soldering copper fittings at the panel, a heat pad will be used to protect the panel finish.

3.14.3 Connections

Install piping adjacent to radiant panels to allow for service and maintenance.

3.15 OPERATION AND MAINTENANCE

3.15.1 Operation and Maintenance Manuals

Submit [six] [___] manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.15.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of [____] hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as

demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --